RAILWAY AND DOCK WORKS.*

The British Association for the Advancement of Science admits to its annual gathering women as well as men; and I venture to think it does so wisely. Women now take their place regularly in the ranks of several scientific professions, and though they have not shown any desire to enter that to which I belong, there has recently been an example of their capability in that direction which is noteworthy. It has been publicly stated that Colonel Roebling, the distinguished engineer of the Brooklyn suspension bridge, which is one of the most remarkable works of the age, was assisted during a long illness in carrying out his work by the talent, industry and energy of his wife, who acquired theoretical and practical knowledge enough to aid in seeing that her husband's design was properly carried out. I think this example is not unworthy of mention here as honorable to the individual woman, to the energetic nation to which she belongs, and to the better half of the human race.

The previous meetings of the British Association have been held in places possessing very varied characteristics; but in none in which the pursuits of science could be undertaken under more pleasing circumstances than in Southport, with which I have been acquainted for a good many years.

It is customary for the president of each section to begin the session by giving an introductory address. I propose, with your kind indulgence, to offer some brief remarks, as far as possible free from technical language, on a subject which is familiar to my own mind, and within my own experience, during a period now approaching half a century, that is: The growth of mechanical appliances for the construction and working of railways and docks.

The railway of the present day is in principle what it was at the outset; but it differs in detail from the original railway as much, or more, than the skewer which fastened the dresses of the ladies of Elizabeth's time, from the pin of the present day, or the carpets of this era from the rush-strewn floors of that. The progress has been gradual, but not slow. From the opening of the first railway to the present date is only a period of about sixty years, and in that short time Great Britain and Ireland, the continent of Europe, America, North and South, India, Australia, and Africa, have been pretty well supplied with railway lines, more and more perfect in construction, and in a degree more or less suitable to the needs of their populations.

The growth of the railway line from a mere plank of wood or iron plate, to a rail laid on stone or a wooden sleepers; from the rail with a flange, to the smooth rail and the flanged wheel, were early and important, but now almost forgotten steps in the progress of the railway system. The substitution of the flanged wheel for the flanged rail was an organic change which has been the forerunner of the great results accomplished in modern traveling by railway. You may easily imagine the condition to which our railways would be reduced if they were constructed on the principal of street tramways; how they would be obstructed by slight impediments, and how difficult the construction of junctions would be rendered, by considering how the speed and convenience of railway traveling would have been retarded if it had not early been discovered that the rail should be lifted clear of the ground, and the guide put upon the wheel instead of the rail.

After the flange had been abolished from the rail, the form of the rail itself took a good while to settle; and even now there is no universal form of rail, though in this country and in our colonies the double-headed rail generally prevails, and on the Continent the flat-footed or Vignoles rail. At the outset the rail was a mere bar of cast-iron, with a surface sufficient for the wheels to roll on, and with a rib deep enough to give strength to sustain the load. Cast-iron chairs were used to hold the rail in position; and as, owing to the nature of the material employed, those chairs were frequently injured, the first efforts for the improvement of the rail were directed to dispensing with the chairs. But the forms of rail introduced for this purpose did not effect their object, for practical reasons which it is not necessary here to go into. Mr. Locke introduced the double-headed rail, the ends of which were at first made to rest in the chair; but the effect of this plan was found to be that the rails were speedily worn at the ends, and they had to be replaced. The fish-plate was introduced to remedy this defect. The fish-plate was a great improvement in the permanent way of railways. It consists, as you are aware, of two plates of iron placed on each side in the hollow of the rail immediately under the head, the plates being held together by bolts passing through them and through the rail, the bolts being screwed up tight to the rail at the joint by nuts. The effect is to make the rails as nearly continuous as is practically possible.

About thirty years ago, when the traffic on railways had been very largely developed, the parts of the permanent way which had at first been thought likely to be the most enduring—the rails themselves—were found to be more rapidly worn away than was expected. Efforts were made to harden the surface of the rails, and a plan was introduced by Mr. Dodds for this purpose. It was extensively used where rails were subject to special wear and tear at points and crossings. The conversion was easily effected; it cost only about fourteen shillings to a pound a ton, and it was estimated that it doubled the durability of the rails. If they were turned, of course it increased their durability three times.

The plating of rails with a steel surface was probably begun about 1854. It was not till about eight or ten years later that rails were made entirely of steel.

In May, 1882, steel rails were laid down experimentally at Chalk Farm Bridge "side by side with two ordinary iron rails, and after outlasting sixteen faces of the iron rails they were taken out in August, 1865, and the one face only which had been exposed during a period of more than three years to the enormous traffic, amounting to something like 9,550,000 engines, trucks, etc., and 95,577,240 tons, although worn to the extent of a little more than a quarter of an inch," even then appeared capable of enduring a good deal more work. Steel rails, however, were dear at that period, costing about double (£12 10s. per ton) as much as iron rails; therefore, although their advantages were manifest, they could not all at once replace iron. In 1866 Mr. Webb, the locomotive engineer of the London & Northwestern Railway, said they had in use 3,000 tons of steel-headed rails and about fifty miles of steel rails, and Mr. Harrison, of the Northeastern, said he had just contracted for 500 tons. Now, owing to improvements in the manufacture of steel rails, they can be produced as easily and as cheaply as iron rails. It was observed in 1876 that if, in order to fully realize the effect of the enduring quality of steel rails, you take a given section of the busiest portion of one of our leading railways, over which upward of 7,000,000 tons of live and dead weight pass annually, you would find that the life of a steel rail on that portion of the line would be forty-two years if the traffic remained the same. This would reduce the cost of maintaining the permanent way of railways from £210 to £106 per mile. When you consider that such a saving on a system of 500 miles, which at £25,000 a mile costs twelve and a half millions, is £52,000 a year, or about half per cent. of the cost of the railway, you will see that, besides some increase of dividend to shareholders, no inconsiderable sum may be, and has been, devoted by the railway systems of Great Britain to the comfort of travellers out of the saving effected by the introduction of steel rails.

You are aware that railways are worked by the aid of an elaborate system of signals, by which those in charge of a train are required to be guided in regard to its movements. When railways were first opened they were worked without any fixed signals, unless a candle placed in a station window on the Stockton & Darlington line may be so designated. The candle indicated that the train was to stop for passengers, and no candle implied no stoppage. No practical steps were taken toward the adoption of fixed signals till the opening of the Grand Junction Railway in 1838. The signal then used consisted of a disc fixed to a spindle with a handle to turn it, with a lamp at night to answer the purpose of the disc by day. This was a mere "danger" and "safety" signal. In the same year Sir John Hawkshaw designed a disc signal attached to movable rails for the Manchester & Bolton Railway, which was set in motion by a handle with a balance weight attached, so that when the switches were open to the siding the face of the disc was presented; and if the switches were open to the main line the side of the disc was presented. The Great Western had a ball signal about the same time for a similar object. The semaphore signal was designed by Sir C. Hutton Gregory in 1841, and erected at New Cross, and was the first great step in advance in railway signaling. Distant signals were first employed in 1846 in Scotland on a branch of the Edinburgh and Berwick Railway, and were generally disc signals. Probably the first signals of the semaphore type were those of the Great Northern, which were made in 1852. Automatic signals were tried with considerable care on the Brighton line, but were abandoned owing to practical difficulties in their working.

As the number of junctions increased, it became apparent that not only must separate signals be given for different lines, but that some kind of concurrent action must be secured between signals and switches to prevent accident. Sir Charles Hutton Gregory, in 1843, at the Bricklayers' Arms Junction, gathered together chains from all the signals into a stirrup frame, and a sort of parallel motion was fixed to the frame between the stirrups in such a manner that the depression of any stirrup pushed the parallel motion so as to block one or more of the other stirrups, and thus it was impossible to give two signals which conflicted with one another at the same time. The switch levers were fixed on the same platform with the stirrup apparatus, but were not interlocked with it. The switchman, while working the switches with his hands, worked the signals with his feet. But the switches were not interlocked till 1852. At East Retford Junction a simple contrivance was used to effect this purpose, which Mr. Ransome considers the germ of the elaborate apparatus which is now used at most of the great junctions throughout the country, the main principle of all the systems being that locking bars moving in horizontal planes should interlock the levers moving in vertical planes.

You are acquainted with the outside at least of those long glass houses built high above the line, at important junctions where hundreds of trains pass rapidly by day and night, and you may have caught sight on your way of the long rows of levers with which they are filled. It is with these handles that the signalman inside the glass house sets the semaphore in motion, and at the same time opens the points to direct the train on to a particular line, and perhaps simultaneously close or lock the points of a branch line, thereby preventing the possibility of a second train coming on to the line previously occupied. When the lever is once drawn over, a mechanical contrivance called a "locking bar" prevents the points being moved until the whole of the train has passed. In fact, with the present apparatus for signaling, the number of trains that may be worked on a line of railway with perfect safety is enormous, and may be said to have reduced the element of human fallibility to as low a point as human ingenuity is capable of compassing.

Audible signals are in use only in foggy weather, and the detonating signal, designed in 1841 by Mr. E. A. Cooper, continues to be generally employed in this country for that purpose.

The subject of brake power is one to which very great attention has been given, both in this country and abroad; and, certainly, next to the condition of the permanent way and the efficiency of the signaling apparatus, perhaps nothing in connection with railways is of greater importance. Many lives and much property are hourly dependent in a greater or less degree on the power and efficient state and immediate action of the brakes. It has been found that most of the collisions which have occurred might have been prevented had those in charge of the trains possessed the power of stopping them within a few hundred yards. The higher the speed and the heavier the train, the greater the necessity for a powerful and simple brake, capable of being applied throughout the train in the shortest possible time.

While trains travelled at slow speeds, and consisted of a small number of comparatively light carriages, the brake on the wheels of the guard's van and the reversing power of the engine were fairly efficient means of retarding the motion, or completely stopping trains within a distance absolutely necessary for the comparatively safe working of railways. But the demands of the public for increased speed, or the increased speed offered as one of the results of competition, and the growing weight and length of trains caused by the rapid augmentation of the number of passengers, outran the power of the brakes to control effectually the movements of the train.

Means were sought to add to the control of trains by brakes: first, by using the power of the steam acting directly on the brakes; secondly, by the connection of several of the old brakes, so as to unite them under the control of a single brakeman; and thirdly, by the introduction of brake apparatus connected with the buffers, so as to make the momentum of the train itself available in generating a retarding force—a result which has not been realized in practice. Colonel Yolland reported to the Board of Trade in 1858 the result of a series of trials with brakes designed on these principles. The application of the brake to the engine was an old device which has been abandoned on account of the injury it caused to the engine. Mr. M'Connell, whose engine brake was tried by Colonel Yolland, appears to have endeavored to remove this objection to a brake on the engine by applying blocks to the rail instead of to the wheels of the engine, the block being forced down on the rail by means of an elbow joint.

Col. Yollard found that the amount of retardation caused by this brake was comparatively small, and insufficient to prevent an imminent collision. The second principle, the connection of several brakes united, under the control of one driver, was chiefly represented by the invention of Mr. Newall. In this system two or more carriages, or, if necessary, the whole train, were fitted up with brake-blocks, all of which were brought under the control of one guard by means of a longitudinal shaft, which transferred the motion of the guard's wheel to the brakes throughout the whole length of the train. In this way an enormous increase of retarding power was obtained, proportioned to the number of wheels, and consequently to the length and weight in the whole train. This principle has been applied in

* Address of Mr. James Brunless, F.R.S.E., F.G.S., Pres. Inst. C.E., as President of the Mechanical Science Section of the British Association, Southport Meeting, September, 1883.

all good brakes since invented, however actuated, and it appears to be sound principle for the application of retarding force, Newall's application of it has only been superseded by the transfer of the motive force from the brake van of the guard of the engine, where it is best placed for immediate application, without manual exertion, and under the control of the engine-driver, who is the first to see any obstruction of the line, and can be easily communicated with by the guard or passengers in case of any other cause for the stoppage of the train than that which may be seen from the front. Indeed, the contrary plan which prevailed for so many years, and is not yet entirely abandoned, appears to be as irrational as it would be to take the reins out of the hands of the driver of a coach and place them in the hands of the guard behind. In principle it may be taken to be admitted that the engine-driver should control the brake, that it should be applied to every wheel of the train, and that in certain cases the brake should apply itself to the wheels. All recent efforts for the improvement of brakes appear to have been devoted to make the action of the brakes automatic, and to increase the rapidity with which they can be applied.

I do not intend to enter into the controversy respecting the best system in use for obtaining these results. There are several systems by which they are attained more or less effectively; and whereas trains which 30 years ago weighed on the average 30 tons, with engines of the same weight, running at the rate of 35 miles an hour, could scarcely be brought to a stand in a distance of about 800 or 1,000 yards, now trains of twice or three times that weight, and running at a much higher speed, can be brought to an absolute rest in 20 or 30 seconds, and within a distance of from 300 to 400 yards.

When railways were first made, the locomotive was a very imperfect machine, which could only travel economically on roads almost level and straight. As there are no level plains of great length in this country, and as reducing the natural surface of the country to a fair level is both tedious and costly, considerable detours were made to avoid steep gradients or their alternative, long tunnels, deep cuttings, and high embankments. In some cases where a very steep gradient could not be avoided, a stationaryengine and rope traction were adopted. The great improvements in the locomotive gradually led to the almost entire abandonment of rope traction in this country: and gradients which it would have been impossible for the earlier engines to surmount with a load equal to their own weight are now ascended with ease with heavy trains at moderate speeds. Abroad, however, great natural difficulties, and a limited capital, were not infrequently a concurrent condition which afforded the engineer troublesome problems for solution. In some districts the locomotive could not do the required work, and other means have had to be resorted to. The plans adopted for overcoming the difficulty presented by the sudden elevation of the surface over which a railway must pass may be typified by the wire-rope system, as employed by myself on the St. Paulo Railway of Brazil, and by the central rail system of Mr. Fell, first employed on the Mont Cenis Railway, and since on steep inclines in New Zealand.

In the case of the St. Paulo Railway it was necessary to solve the problem of rising a height of more than 2,500 ft. in five miles; and as the cost of the construction of the line was strictly limited this had to be done with due regard to the cost of the remainder of the line, and also to the proportion of cost of working it in the total working expenses. I chose the stationary engine and wire-rope system as the best in the circumstances, and divided the ascent into four inclined planes, each with a gradient of 1 in. 9¾ ft., and of an average length of about a mile and a quarter. At the top of each there is a bank head, with an incline of 1 in. 75 ft. downward, where the stationary engine is placed. The inclines are worked by what is known in the north of England as "the tail-end system," and are thus self-acting, wagons being attached to each end of the rope, and being raised and lowered simultaneously. The arrangement of the rails is peculiar. On the lower half of each incline an ordinary single line is laid, and on the upper half, above the passing place, three rails are laid, forming a double road with a central rail common to both. Exactly half way on each incline the single line of the lower half and the three rails of the upper half branch out into a double line of way of sufficient length for the trains to pass each other.

This arrangement allows of two lines of pulleys for carrying the ascending and descending part of the rope, to be laid down above the passing place, while on the lower half a single line of pulleys only is required. Each incline has a winding engine of 150 horse-power. The ropes are of steel wire, and four inches in circumference. There are some special contrivances for keeping the rope in place and for controlling the movements of the train, but I need only refer to the clip brake, which is supplementary to the ordinary brake. The clip brake grips the rails, and in an emergency which has arisen, owing to the breaking of the rope hauling a goods train, the application of the clip brake arrested the train in a distance of 66 ft., the rope was spliced, and in three hours the traffic was resumed.

The central railroad system was designed by Mr. Fell, and first carried out practically in the railway made over Mount Cenis, under my direction, before the opening of the great tunnel. The peculiarity of the system lies in the use of a deep rail laid on its side between the two ordinary rails; the center rail is gripped by horizontal wheels put in motion by the locomotive, the adhesion of which to the center rail gives the locomotive the force necessary to draw up steep inclines not only its own weight, but a considerable supplementary load. This is probably the most economical mode of working very steep gradients under ordinary circumstances, and it has been found to answer very well wherever it has been efficiently carried out.

In the early days of railways the only means of tunnelling through hard rocks was by the slow and costly process of the jumper and blasting. A hole was drilled with a steel pointed implement, and when it was worked to a sufficient depth to receive a charge of gunpowder the explosive was inserted, the hole was closed, and, by means of a slow fuse the powder was ignited and a portion of the rock was brought down. Many forms of machine drills have been invented by which this process was shortened—some acuated by hand, and others by steam, air, or water-power. What is called the "Diamond Rock Drill" was an improvement on the drill itself; the steel cutting-surface being superseded by coarse diamonds set in a ring of metal. Several of these drills were fixed on a frame, and being actuated simultaneously, a corresponding number of holes were at once driven in the face of the rock. Besides the increase of speed in driving each hole, many holes being driven simultaneously, great additional speed in forming the tunnel was obtained. This has been exemplified in cutting the Mont Cenis and St. Gothard tunnels in Europe, and the Hoosac Tunnel in Massachusetts, where the length of tunnel to be made through hard rock would have rendered the cutting impracticable by hand labor within reasonable limits of time and expenditure. For cutting tunnels through the softer rocks, such as sandstone and chalk, machines which cut or scrape away the face have been invented and applied with considerable success. Mr. Brunton's machine was employed experimentally for cutting a driftway in chalk for the Channel Tunnel Company, in 1870, and it worked freely at the rate of about a yard an hour, excavating a heading of 7 ft. diameter. A machine of this kind has recently been sent to Sydney to make sewers through the sandstone. Colonel Beaumont and Captain English have invented a machine which effects the same object in a somewhat different manner. This machine has been employed in cutting driftways in the chalk at the rate of about half a yard an hour, both in France and in England, and is employed under my direction in cutting a 7-ft. heading in the red sandstone of the Mersey Tunnel, with considerable advantage.

These machines bore the heading, and clear away and load the spoils into wagons, at one operation, and they enable the engineer to dispense entirely with the use of explosives. By this means the surrounding stratum remains intact, no more disturbance taking place than would follow the driving of an augur through a dead board. They are moved by any available power according to the situation; in the cases I have mentioned they have been driven by compressed air, which, as well as driving the machine, effects the ventilation of the heading in which the machine works.

In the construction of railways and docks one of the most expensive and tedious operations is the excavation of the soil. In England the cutting of numerous canals had trained a large body of men to special fitness for the execution of such work, which they performed with a manual dexterity and amount of muscular power which have made the British navy a special force in the execution of great public works. Where labor was comparatively scarce and efficient—as, for instance, in America—efforts were made at an early period to supplement, and if possible supersede such manual labor by mechanical contrivances. In 1845 a mechanical excavator after an American model was used on the Eastern Counties Railway with a certain amount of success. This machine delivered as much as 100 cubic yards an hour at a cost which did not exceed 50s. a day. In principle, and generally in detail, it is very much the same as the excavator which is commonly known as the "steam navvy" at the present day. The machine was locomotive, and had three other kinds of motion—first, thrusting the scoop or shovel into the earth; second, lifting the scoop when filled; and, third, turning round on its center to deposit the earth in the wagons. At that time thirteen of these machines were in use in the United States; but they have not superseded manual labor in making cuttings and embankments there, and they have been little used here until recently, and even now they only compete successfully with bone and muscle under special circumstances. It is found economical to employ the "steam navvy" where there is a large quantity of hard and heavy clay or alluvial soil to excavate, and where the machine will not only effect a gross saving per day, but nearly pay for its cost in the course of a single contract. The disadvantages of the machine are that it is costly, very heavy to move, requires special plant to work with it, is not readily salable when the work is finished, and costs a good deal to keep in repair. On the other hand, it will work night and day without trouble, it renders the contractor independent of a large amount of hand labor, and it will work readily in soil with which it is extremely difficult for manual labor to deal. It is much to be desired that the human frame should be relieved of the exhausting labor which makes man a mere beast of burden, and leaves him at the end of his work only fit to lie down to sleep off the effects of his toil, and to regain strength to continue the same round of labor on the morrow. The use of small locomotives for tipping the soil for embankments has relieved the workmen of one very laborious and sometimes dangerous occupation, and in a corresponding degree has diminished the cost of construction.

TO BE CONTINUED.

AGAINST THE ELEVATED ROADS.

The suit against Dr. G. Fayette Taylor and another against the Metropolitan and Manhattan Elevated Railways to recover $25,000 was ended on the 24th in the Superior Court, before Chief Justice Sedgwick and a jury, with a verdict of $20,000. The plaintiffs sought to recover damages for depreciation of property and injuries to their business at the southwest corner of Fifty-third street and sixth avenue, where they treated various diseases. This was the second trial, the jury in the first trial failing to agree. The plaintiffs leased the property before the road was built, and they claimed that the elevated trains injured their business on acconnt of the dirt, noise, foul gases and obstruction of light and air consequent upon running them. In the course of the trial Mrs. Clarkson N. Potter testified that she went to Dr. Taylor's establishment to be treated, but, owing to the noise of the trains, was unable to sleep and had to go elsewhere. Other depositions of a similar nature were made. The defense claimed that the roads were legally built and were a public necessity.

THE *Herald* says editorially: The twenty thousand dollar verdict which a jury gave Dr. Taylor, yesterday, is a serious matter for the elevated railroad companies. The Court of Appeals has decided that these corporations are liable for damages to property on the streets through which the roads run. This decision is final on the legal queston of liability. It settles the right of every injured property owner to sue the company for damages. It is for a jury to decide whether any damage has been sustained, and, if so, to what extent.

The suit that resulted in the heavy verdict is but one of many that may be successfully brought against the companies. Of course, the corporation will make every effort to have the verdict set aside. But to accomplish this it must show either that the damages awarded are excessive or that there was some irregularity in the conduct of the trial. The company is barred by the decision of the Court of Appeals from denying its liability for damages.

TECHNISCHER VEREIN, ANNUAL MEETING.

The Technical Society, of New York, at its Annual Meeting on October 13, 1883, elected the following officers and trustees for the year 1883–4:

President, Paul Goepel; Vice-President, Geo. W. Wundram; Corresponding Secretary, Max C. Budell; Recording Secretary, Carl Stagl; Treasurer, Anton Heim; Librarian, F. M. J. Nolten: Directors, Dr. H. Endemann, Augustus Kurth and Hugo R. Roelker.

Chairman of the Four Sections: Civil Engineers, Theodore Pasihke; Mechanical Engineers, Ferdinand Rochow; Architects, Theodore De Lemos; Chemists and Mining Engineers, E. J. Schmitz.

The number of members is 247, of whom 140 reside in New York and vicinity, the others all over the United States, Central and South America and Europe.

The Committe for Employment reports that a considerable number of newly-arrived colleagues were provided with suitable positions; not a few of the members availed themselves of the opportunity, furnished by acquaintances formed in the Society's meetings, of bettering their conditions.

The Society was incorporated on the 20th inst.

The incorporators are: P. Goepel, Anton Heim and Hugo B. Roelker, of New York, and Geo. W. Wundram, Max C. Budell, Dr. H. Endemann, Augustus Kurth, C. Louis Nagel, Fred. Thomass and W. Ultzen, of Brooklyn.

MAX C. BUDELL, Cor. Secretary.

THE WATER SUPPLY OF CITIES IN ANCIENT TIMES.

BY WALTER ATLEE, C. E.

It would seem to be particularly interesting, at the present time, to give some account from ancient authors of the manner in which the famous water supplies of Rome and other cities celebrated in antiquity were conducted. Ever since men have increased in numbers, and have dwelled together for a more or less time in one locality, great attention has always been given to obtain a permanent and abundant supply of pure water. Among pagan nations water was regarded with such reverence that it was customary to give names to fountains and to place them under the protection of the gods. The ancient Egyptian priests, in order to show that all things could subsist only by the virtue of this element, carried solemnly, with religious respect, into the temple where their god was supposed to reside, an ornamental vase filled with water, and there prostrating themselves on the earth, with their hands raised, gave thanks to the divine goodness for his admirable inventions.*

In ancient Rome was celebrated annually on the III. Ides of October (October 13), the feast of the fountains, under the name of Fontanalia. During the half-day which the celebration lasted, the fountains and wells were crowned with flowers, and wreaths were thrown into the springs of running water. The Germans, even a long time after the introduction of Christianity, continued in certain districts to make pilgrimages to several fountains consecrated to pagan gods. If history furnishes but few and scattered accounts of the art of supplying cities with water, we find in national traditions and monuments the proof that the science of hydraulics dates back to the most remote antiquity. We know that Persia possesses canals for irrigation, the origin of which is lost in the "night of ages," and which, nevertheless, continue at the present day to perform their functions. In the Province of Anachosia ruins of canals attest the former existence of a vast system of irrigation. At Memphis is the ancient aqueduct of Sestorius. Semiramis constructed at Babylon her celebrated aqueduct.

The city of Jerusalem was supplied by water through an aqueduct built by Solomon. The whole plain at Persepolis was at one time traversed by hydraulic constructions, the ruins of which show that conduits made of stone and pottery large enough for a man to enter were supported by masonry above the level of the plain. The traveler Tavernier went from Aleppo to Ispahan by the route of the Great Desert, and arrived at a large abandoned palace, before the entrance to which was a reservoir communicating with a canal, then completely dry; the bottom and the roof, which latter was level with the surface of the ground, were constructed of bricks. The Arabs who accompanied Tavernier said that the canal had served to bring water from the Euphrates, which was at least 50 miles distant. Joseph's Well, at Cairo, although of more recent date, is probably the most wonderful subterraneous work ever performed by man. A brief and clear account of this structure is given by Ewbank. There is also at Cairo a long aqueduct, built of masonry, which for its greater length is supported by arcades, constructed about the same time as Joseph's Well.

The engineering skill of the ancient Greeks is shown by the celebrated aqueduct constructed by Eupalinos, of Megara, which Herodotus mentions as one of the wonders of the island of Samos;† this excedingly interesting object for the archæologist pierces, for 2½ miles, the heart of the mountain back of the town, whose inhabitants it supplied with water from a perennial spring. From an article in *Macmillan's Magazine* for August, 1883, we learn that a priest named Cyril, from the monastery of the Holy Trinity, last spring, while plowing, discovered the long-lost southern entrance of this aqueduct. At a cost of 20,000 francs the Samiotes have now almost completed the restoration of the ancient channel, with the view of again utilizing it in supplying the town with water. Among the ruins of the aqueducts of ancient Greece, that of Patara, in Lycia, is most interesting. It consists of a siphon constructed with cut stones, supported by an arch in cylopean masonry, dating to the most remote antiquity.

But it is, above all, the Romans who particularly attract our attention by their hydraulic constructions, the magnificence and daring of which surpass those of all other nations. Rome is the only city of antiquity of which we have any detailed account of the administration of the collection, conveyance and distribution of water. The Romans, enabled by their enormous wealth to gratify their love of display and indulgence in luxurious habits, constructed those monuments of hydraulic engineering which Frontinus speaks of as being "worthy of the greatest care, since they are a principal testimony of the grandeur of the Roman empire," "*rem enixiore cura dignam, cum magnitudinis romani imperii id præcipuum sit indicium.*"* At the fall of the Republic, 45 B. C., Rome, according to Frontinus, possessed four aqueducts—the Appia, constructed in 442 Roman era, by the Emperor Appius Claudius; the Anio Vetus, built in the year 481 Roman era; the Marcia and the Tepula. The emperors Augustus Caligula, Claudius and Trajan constructed at Rome other aqueducts, more magnificent than those of their predecessors, so that at the time of Frontinus (850 Roman era, or 97 B. C.) there existed eight aqueducts, namely (in addition to the four already mentioned), the Julia, the Virgo, the Alsetina and the Claudia. The aggregate length of these most useful monuments was 267⅞ miles. For 228⅝ miles the channels were entirely underground, and for 39 miles above the surface of the ground; of the latter 34⅞ miles were supported by arcades or ranges of arches.

The following brief account of the character and construction of the Roman aqueducts is mainly taken from "Les aqueducts Romains," by M. Belgrand. The first aqueducts, the Appia, the Anio Vetus, and, above all, the Marcia, bear the robust character of the masonry of the earliest ages. They were constructed of cut stone, very simply dressed, but adjusted with precision, so that we see that the engineer relied more upon the resistance of the stone than that of the mortar. The Tepula aqueduct was built in 627 Roman era, or but 19 years after the completion of the Marcia; nevertheless the mode of construction was different. During that time the Romans had become masons and understood that with good mortar and rough material they could produce a construction as solid as with cut stone and at a much less cost. The same mode of construction was employed in the other aqueducts, with the addition of the introduction of bricks, except in that of the Anio Novus, which, when it approached the city, surmounting the Claudia, took a character of magnificence, the rough materials being abandoned and cut stone entirely employed. The cross-sections of the channels through which the water ran varied from 3 to 8 ft. in height, by 2½ to 5 ft. in breadth; the bottom was horizontal and the sides perpendicular to it; the shape of the top or covering varied even in the same aqueduct, it being sometimes arched and at others peaked, and sometimes horizontal or parallel with the bottom.

The necessity of maintaining the aqueducts at a gradual inclination from their sources in the mountains to the place of delivery of the water in the city forced the engineers, when they came to the numerous abrupt and deep ravines of the Apennines, to build up sub-structures consisting of one or more arches, and often of several ranges of superposed arches where it was necessary to attain the required elevation. In traversing the valleys it was often necessary to construct those arcades, the ruins of which are at the present day the wonder of all who behold them, and no traveler considers that he has seen all the curiosities of Rome till he has visited at least the Plain Roma Vecchia, which is so remarkable for the ruins of the ancient aqueducts, especially for that of the Claudia, surmounted by the Anio Novus, distinguishable by a high and exceedingly long line of arcades, extending beyond the power of vision. The first four aqueducts constructed across the valley Degli Archi in the Apennines on magnificent arcades, the ruins of which are classed among the most curious of Italy. There is an aqueduct bridge of the Anio Vetus composed of 35 arches forming two ranges of arcades superposed, which traverse the valley now called St. John. The aqueducts Anio Vetus and Marcia descended by regular grades the mountains Spaccato and St. Angelo, and crossed the first ravine of the Apennines on the same bridge, also composed of two ranges of arcades. This ruin, now called St. Anthony's bridge, is considered very beautiful.

The want, more and more pronounced, of water at a higher elevation obliged the Roman engineers, especially in crossing the plain near Rome, to support the aqueducts on higher and higher arcades. Thus, the elevation of the Marcia water being insufficient, the Tepula, 19 years afterward, was constructed at a greater altitude. Ninety-two years later the Julia was built, at a still greater elevation, and 84 years after the completion of the Julia, the water still being too low, the high arcades of the Claudia were superposed on those of the Anio Novus, crossing the plain near Rome at an elevation of 109 feet above its surface. Not only at the Eternal City, but wherever the Romans extended their conquests and established cities, they built those gigantic hydraulic monuments which prove to posterity the great importance they attached to the enjoyment of an abundant supply of water. Among the ruins of these beautiful constructions with which Gaul was dotted after the Roman conquest, there still remain several aqueducts in active service. That called at present the *Pont du Gard* supplies the town of Nimes with water from the two springs, Aire and Airan. This aqueduct consists of a stone channel, 291 yards long, supported by three ranges of arches superposed and attaining an elevation of 160 feet. At Metz the Moselle River is crossed by the aqueduct Segovia, which brings water from the valley of George, 23 miles distant. A part of the water of Paris is still supplied by the Roman aqueduct passing near Arceuil.

Nothing gives a higher idea of the ancient splendor of the City of Lyons (Lugdunum) under the Roman Emperors than the remains of the ancient aqueducts erected under Augustus, Tiberius and Claudius to furnish the city with water. But no country shared so well in grand Roman hydraulic monuments as Spain, where aqueducts and baths, or their remains are found in most of the large towns. Those of Merida, Toledo and Tarragona are worthy of being compared to those of Rome itself. The aqueduct of Segovia, in spite of the ravages of time, of civil and political disturbances, has never ceased to fulfill its ancient purpose, and to-day still furnishes the city with all the water necessary for its consumption. This aqueduct, 19 miles in length, is justly celebrated for its admirable, arcades, 700 yards long, composed of 109 arches supporting the channel at an elevation of 107¼ ft. above the valley.

Constantinople, the Rome of the East, was also justly celebrated for its water supply brought to the city by the renowned aqueducts of the emperors Valens and Justinian. The magnificent Carthegenian aqueduct carried its supply of water through mountains and over valleys for 70 miles; near the town of Undena it was supported by an arcade of more than a thousand arches, the elevation of the channel exceeding in some cases 100 feet above the surface of the ground. Rome was long celebrated for the purity and freshness of its water. The Romans knew that spring and well waters alone were suitable for drinking and culinary purposes, that river water should be reserved for watering and washing streets and parks, to supply the needs of industry, ornamental fountains and the celebrated amphitheatres where they were so fond of witnessing the famous naval sham combats. They knew that water, to be good, should be limpid, of a moderate temperature in winter and summer, inodorous and above all of an agreeable taste. Vitruvius* tells us "that we can, by means of several observations, know the quantity of the water of a district. If it flows along the surface of the ground, it is necessary, before inclosing it in conduits, to consider the physical condition of the inhabitants; if they are robust and have good color, and are not subject to diseases of the limbs or running from the eyes, the water may be considered fit for use. To test the quality of the water of a newly discovered spring it is necessary to throw several drops of it on Corinthian brass, and if it leaves no spots it is a sign that the water is excellent. It will be the same if, after having been evaporated, no mud or muddy deposit remains, and if vegetables boiled in this water cook quickly. Finally, we shall know that the water is light and very healthy if, being clear and beautiful in its source, it deposits in the places by which it passes neither moss, rushes, nor other impurities."

Until the 442d year after the foundation of Rome, or 310 years before the Christian Era, the inhabitants of the Eternal City contented themselves with water from the Tiber and from the most agreeable springs of the locality. They had at the foot of Mount Cœlis the fountain of Mercury; on the Palatin Hill the fountain of Saturn; from the famous grotto of the Louvre still flows the Lupercale water; in the same neighborhood is also the spring of Castor and Pollux.† A. Cassio speaks also of four other springs—those of Lantulus, of Picus and Faune, of Cybele and the nymph Egeria. For the waters of these springs and fountains the Romans had a profound veneration. When Rome became powerful and rich she knew of no better manner in which to employ the plunder and slaves procured by her victorious arms than by constructing monuments as remarkable for their daring in architectural design as for their utility. She therefore constructed her famous aqueducts, thus availed her-

* Vitruvius, lib. 8, preface.
† Herod, lib. 3, ch. lx.

* Frontinus, ch. cxix.

* Lib. 8, ch. v.
† Belgrand, Idem, p. 17.

self of the remarkable advantage of being situated on seven hills, at a distance not too great from the Apennine Mountains, which contain, at a much greater altitude, innumerable springs and lakes of pure water, by bringing for the health, comfort and luxury of her inhabitants this pure liquid to the summit of these hills, by means of gravity, through aqueducts, and thence distributing it throughout the city. The sources of water of the Marcia and of the Claudian aqueducts are each 1,030½ ft. above their respective locations of delivery. The water of the Marcian spring, on account of its remarkable purity and agreeable taste, was reserved, by an edict of the Emperor Nerva, for drinking. Frontinus considered it a sort of profanation to have used this beautiful water for ordinary purposes.

The Romans having decided upon the springs or lakes from which they wished to augment the supply of water for the Eternal City, and having assured themselves that the sources were situated at an elevation sufficiently greater than that of the locality where they wished to deliver the water, first collected the water into reservoirs, from which it ran through a channel built of masonry on a regular incline, so that the water might run by the action of gravity to the storage reservoirs from which it was distributed. Sometimes the water was made to pass through intermediate reservoirs, for the purpose of purification, by permitting the water to remain at rest long enough for the mud and other impurities carried along by the force of the motion of the water, to fall and be deposited on the bottom of the reservoir. Near the seventh milestone from Rome, on the Latin road, six of the aqueducts emptied their supply of water into covered wells or reservoirs, from which the water continued its journey through aqueducts to the walls of the city, where it was received in "castelli,"* or water towers, which were structures built of masonry inclosing a basin, near which were three reservoirs fed from the basin by three pipes which distributed the water equally. These reservoirs were so placed that the center one would receive in times of abundance the surplus water of the other two. From this reservoir of the center the water was distributed to the public fountains and ampitheatres. The public baths were supplied with water from one of the other reservoirs. Private establishments obtained from the third reservoir their supply of water. The water towers of the Julia and Claudia aqueducts were very important monuments, the ruins of which still remain.

Besides the public water towers, there were private and special towers, which in the time of Frontinus numbered in the city of Rome 247. The public towers received the water directly from the aqueduct, or from a branch of it, from which a portion of the water ran continously through leaden pipes into the public fountains of the vicinity, from which most of the people obtained the water necessary for domestic purposes. The inhabitants of those portions of the city more distant from the public water towers, into which the aqueducts emptied, were supplied with water from special towers, to which the water was brought by conduits from the public towers. Private dwellings were supplied directly from the nearest water tower, or, when situated at a too remote distance, the wealthy inhabitants were accustomed to build private towers for their special use. These towers and the dwellings were each supplied by their special conduits in lead or pottery, each conduit receiving its amount of water from an opening in the water tower, to which was attached horizontally a bronze pipe or gauge of a diameter and length regulated by law, in proportion to the amount of water to be supplied; this diameter was maintained for a distance of 12 digits, or 9 inches, for if the opening alone were of the required diameter and a larger pipe were attached, immediately the pressure on the water would cause it to fill the larger pipe, and thus supply a greater amount of water than that granted by the concession. This bronze pipe was therefore a sort of meter, which if properly placed and the water of the reservoir maintained at a certain elevation, would indicate the amount of water supplied. From this gauge or meter the water was conducted through conduits in lead or pottery under the paving of the streets to the dwelling of the consumer, where it ran continuously, day and night, from a fountain into a sort of basin reservoir, called the "impluvium," forming a part of the "atrium" or the vestibule characteristic of the dwellings of the wealthy Romans. This arrangement can be seen in all the large houses at Pompeii; the smaller houses were not supplied with water; the artisan dwelled in his shop and procured the necessary supply from the public fountain.

The houses were thus supplied with water through special conduits, directly from the resorvoir; the water ran continuously in the court of the dwelling, and not through a large conduit, distributing the water to all the houses near which it passed, nor was the water distributed throughout the dwellings as is customary at the present day. This mode of distribution rendered the expense of a private supply of water very great, for in addition to his portion of the expense of the maintenance of the tower of the district, the proprietor was obliged to bear the expense of laying the pipe, repaving the street, and maintaining in repair this conduit, which was often necessarily of great length. Through this custom of permitting the water to run continuously, much the greater quantity distributed for public and private service ran to waste. The Emperor Nerva ordered this surplus water to be used so as to continually flush the sewers and wash the streets; through some of the latter it ran continuously, a system so inconvenient that it would not be tolerated at the present day. Indeed, it would seem that the Eternal City would have become uninhabitable but for this abundant supply of water. Frontinus considered this employment of the surplus water as one of the benefits of the reign of the Emperor Nerva; he says, "that the superabundant water was no longer useless; the sanitary condition of the city was already changed, the air purer, the causes of that pernicious air, of that infamous air of the city of our forefathers, were destroyed."

Vitruvius has left us a detailed account of the manner in which very long valleys could be crossed by means of the siphon; but the Romans were only able to employ the siphon where but a small quantity of water was required, for they had not made sufficient advance in the working of metals to be able to economically employ any but lead pipes, and these were of such an inferior quality that the force of the water would often burst the pipes, especially in the curves. According to the very careful calculations of M. Belgrand,* the water entering the nine aqueducts existing at the ascension of the Emperor Nerva, amounted to 252,000,000 gallons each 24 hours, corresponding to about 252 gallons for each inhabitant of the city; about 27,000,000 gallons of water were extracted inside, and as much outside, the city, in the name of Cæsar, for the use of imperial property, but much the larger quantity (estimated at 83,333,300 gallons) was extracted by fraud. Frontinus tells us that he found fields irrigated, taverns and drinking places supplied by water, the proprietors having fraudulently turned the public water from the aqueducts. Frontinus applied himself so assiduously to prevent these fraudulent extractions of water and with such success that he says, "the quantity of water recovered could be regarded as a new acquisition."† According to M. Belgrand, the amount of water was thus increased to 132 gallons for each person every 24 hours. The water conceded for the public service in the time of Frontinus supplied 19 fields, 39 amphitheaters, 591 fountains and lakes, and 94 public establishments.

In the beginning the distribution of water for the city of Rome was very simple; all the water ran from the reservoirs into the public fountains—individuals could only use the water which fell from the inlet of the fountain into the basin. This water, after it had run from the basin of the fountain, was conceded to the public baths and for the use of fullers; they having obtained the right in consideration of paying an annual water rent to the treasurer. Later, the water which escaped from the aqueducts through leaks was sometimes granted by concession to individuals. Frontinus‡ very justly remarks that these concessions favored frauds of many kinds, and were, consequently, very rarely granted by the emperors. The administration of the water supply was confided sometimes to those holding the office of "censor," and at other times to those holding the office of "edile." The maintenance of the aqueducts was ordinarily contracted for, and the contractor was obliged to keep a certain number of slaves employed on the aqueducts. The names of these workmen, their duties and the location in which they were to be employed, were inscribed on the public bulletins. Their work was subject to the approval of the official in charge of the administration of the water supply. The administrator regulated all the details of the service. On the days of the great performances in the amphitheatres no one was permitted to use even the most necessary water without a special order from the administrator.

There were very severe laws against those fraudulently turning the water from the aqueducts; fields thus irrigated were confiscated, and the public contractors who permitted the frauds were arrested. Those convicted of wilfully impairing the quality of the water were fined 10,000 sesterces ($280). To insure the execution of this, two citizens in each district were chosen from among the inhabitants or property-holders in the neighborhood to oversee the public water. These laws, which punished so severely offenses which by public opinion were not considered dishonorable, were consequently very inefficacious, and must have been very little better than a dead letter, for it would have required but little attention and care to have prevented the aqueducts from being opened and the water turned away, and to have prevented the planting of trees and the building of houses over the underground portions of the channels. Nevertheless, the most scandalous abuses are noted by Frontinus as being customary. In the year of Rome 719 the supply of water became insufficient for the wants of the inhabitants. M. Agrippa, son-in-law of the Emperor Augustus, then holding the office of edile, completely restored the then existing aqueducts, and constructed at his own expense two others—the Julia in the year 719, Roman era, and the Virgo 13 years later. He reorganized and introduced admirable order into the administration of the water supply of Rome, opened a regular account of the receipts and of the distribution of water for public and private concessions; he made laws to insure the preservation of the aqueducts and the maintenance of an abundant supply of water. He made out in detail the amount of water to be distributed to each water tower and from which aqueducts the supplies should be drawn, the quantity to be employed for public use and the amount to be distributed to individuals. He employed and maintained, at his own expense, a family of slaves, consisting of 240 men, for the preservation of the water supply, the care of the aqueducts, water towers and reservoirs. Agrippa, having thus rendered his term of office when edile celebrated for the care he took to increase the water supply by the restoration of the ancient aqueducts and by constructing two new ones, and, above all, by the complete reorganization of the administration, so as to insure the preservation of these edifices and the abundant supply of water, was the first to be intrusted with the superintendence of the water supply for life.

Those charged with the administration of the water supply of Ancient Rome were chosen from among the most illustrious citizens. Frontinus gives the names of his 17 predecessors, who were all great personages or belonging to illustrious families, men distinguished for military or civic virtues, successful commanders, ex-consuls and other dignitaries, were among those considered worthy and capable of being intrusted with the superintendence of the distribution of water and the preservation of the aqueducts. They alone were held to possess the talents, experience and integrity necessary to properly conduct this most important department of the administration of the Eternal City. Until the death of Agrippa the administration of the water supply of Rome had been regulated by special authority, and was subject to no general law. The Emperor Augustus confirmed by an edict the permits recorded in the registers kept by the order of Agrippa, and having inherited the slaves employed for the preservation of the aqueducts, he donated them to the State. He established the gauges by which the quantity of water was regulated and limited to 25 the number of openings permissible in each tower. He nominated Messala Corvus to exercise the functions of administrator of the water, and empowered him to make laws regulating the supply. He granted him two assistants, and to them were accorded the same marks of dignity as were given to magistrates. When they exercised their functions outside the walls of the city, they were surrounded by a numerous escort composed of two lictors, three public slaves, an architect for each of them, clerks, messengers, tipstaves and criers equal in number to those accorded to the functionaries who distributed the wheat to the people. When they exercised their functions inside the city the lictors were withdrawn.

We thus see that the dignitary in charge of the maintenance of the water supply of Rome was empowered to exercise force in performing his duties. It was decreed that during the fourth part of the year they were to attend to the public and private demands relating to the distribution of water, but this order fell into disuse, either from the negligence or from the inability of some of the administrators, although the public treasurer continued to pay the tipstaves and other employés, who ought during that time to assist the administrators. The administrators were especially advised to prevent any distribution to individuals without an order from the prince, so that no one might obtain any public water that had not been granted him, nor any one receive more than was conceded to him.[1] This law has been so much neglected that Frontinus tells us "that by enforcing it he would be able, with the quantity of water recovered, to establish new fountains, and to supply new permits of the prince, and that it was necessary at all times to prevent fraud, by an active superintendence; in order to do so successfully, the aqueducts outside of the city should be visited from time to time, and also the water towers and public fountains, to enable the administrator to become acquainted with the nature of the concessions and to insure the flowing of the water night and day without interruption."[2]

Frontinus, in his "De Aque Ductibus Urbis Romæ Commentarius," says: "Everything confided to us

*Vitruvius, lib. 8, ch. vi.

* Les aqueducts Romains, pp. 98 and 105.
† Frontinus, ch. lxxvii.
‡ Id., chaps. cx. and cxl.

1 Id., ch. cxv.
2. Frontinus, ch. cxiv.

by the Emperor requires our greatest care, but I feel myself naturally disposed as much by duty as by taste to acquit myself well of the new functions with which the Emperor Nerva, a prince as zealous as well-intentioned for the interests of the Republic, has just charged me in confiding to me the administration of the water of Rome, both for their use and for their purity and safety, a function which has always been exercised by the first citizens of the State. I thought that the best way was to do in this as I have done in other circumstances, in order to well understand the object of my enterprise, and I do not believe, in fact, that there is a surer way to be able to judge well of what should be done and what should not be done, nor is there anything more shameful for an administrator than to act only by the counsels of his agents, which must certainly occur when the chief, from want of experience, is obliged to have recourse to those who should be under his direction and who, although necessary, ought only to be regarded as the hands and instruments of the administrator. This is why I have followed in this the same method that I have pursued in several of my other functions, in arranging in order all the information I could obtain concerning this object, united in one body in this commentary to serve me as a guide during my administration."

Those who wished to have a concession of the public water had to obtain permission from the prince by a letter, which, if approved, was presented to the administrator of the water supply. The latter placed the affair in the hands of his assistant, who designated to the guardians of the water tower from which the water was to be drawn the location of the opening to be made, and the size of the gauge to be attached in accordance with the quantity of water conceded. A concession lasted as long as the person or persons lived in the locality for which the water was granted. This right could not be transferred to a purchaser of the locality nor could it be inherited with the property. But the public baths had the perpetual use of the water which had once been accorded to them. These long concessions were rendered necessary by the expense required to conduct the water to the locality to be supplied, often a long distance from the aqueduct, and requiring the construction of a private water tower or reservoir. When a concession became vacant, through the death or removal of the proprietor, it was publicly announced. The administrators had been accustomed to stop the distribution of water immediately on the expiration of a concession, and to sell the right to the new proprietors or to others; but the Emperor Augustus ordered thirty days to be granted, so as not to stop too suddenly so necessary a supply, and to give time to make the customary demands for the renewal of the concession. Concessions were afterward made of the surplus water, which ran from the reservoirs and from the leakage of the aqueducts. This last was very seldom permitted by the princes, for it was easy to enlarge the fissure so as to supply any quantity of water desired, and this flow aided the rapid destruction of the aqueduct itself.

Frontinus having measured the quantity of water entering the aqueducts, and having ascertained that it greatly exceeded that which was registered as having been employed for public use or granted by concessions, set to work to find by what negligence or fraud this great quantity was lost to the State, and to understand how to prevent it. He tells us that he found gauges of a diameter larger than was permitted by the concessions, some of which were not marked, which proved the dishonesty of the agent who controlled the placing of the gauges, he having been bribed to furnish more water than was justly due. In certain water towers the gauges were of the right size at the opening, but instead of maintaining this diameter for the distance required by law, a larger tube had been attached to the opening, thus furnishing more water than allotted by the concession as already described. The locations of some of the openings were below those of others; thus on account of the greater pressure upon the lower openings, they supplied a proportionately greater quantity of water. In several towers, pipes were attached to the openings without any gauge, but were so arranged that they could be enlarged or contracted at the will of the guardian. Another very reprehensible fraud on the part of the guardians was, when a concession changed hands, instead of using the old opening to supply the person obtaining the renewal of the concession, to pierce a new opening and to sell the water from the former for their own interest. Frontinus adds that the suppression of such a fraud should attract the special attention of the administrator of the water, for it is his duty to take care not only of the water, but also of the preservation of the towers, for the latter would be very soon ruined if holes could be arbitrarily pierced. In examining the condition of the different branches of lead pipes placed under the pavements, which circulated throughout the whole city, they were found to be pierced with holes in many places by an instrument called a "pointer;" the water flowing from these holes was sold by the purveyor for his own profit to all those wishing to arrange with him, the water being led from these openings by private tubes to the dwellings.* A large quantity of water destined for public use was turned from its legitimate course in this manner, as Frontinus† proved by the increased amount received at the outlet of several pipes after the holes had been closed.

The labor required to preserve the aqueducts and to maintain a proper distribution of the water was performed by the men of two families of slaves. One family[3] belonged to the public, having been inherited from Agrippa by his father-in-law, the Emperor Augustus, who gave them to the State, as already mentioned. This family comprised about 240 men. The second family, consisting of 400 men, belonged to the family of Cæsar, and was established for this purpose by the Emperor Claudius when he built his aqueducts. These men were classified according to the work they were required to perform—into guardians of the water towers, inspectors, pavers, pipe makers and laborers. A certain number of these men were required to live outside the city, in order that they might be able to repair promptly any damage caused by accidents to the aqueducts, for although the damage might be slight at the time of occurrence, the force of the running water would very soon increase very materially any crevice in the masonry through which it might escape, and thus not only delay the supply of water to the city, but destroy the foundations of the aqueduct. Some of the guardians were lodged in the water towers. All the other men dwelt in the vicinity of the water towers and amphitheatres which were supplied with water, and were expected to continually hold themselves in readiness to aid in abating any damage caused by accident, and when necessity required, to aid in directing the supply of water ordinarily running to several districts at once into any special district requiring immediately a more abundant supply.

Frontinus tells us that he found that these men, through the negligence of the overseers, were accustomed to leave the duties required of them for the public good and to work for their own individual profit. To re-establish and keep order among so great a number of men as composed these two families,[3] Frontinus required that the work to be performed on the morrow should be designated the previous evening; he also kept a record of the work performed each day.[4] These men were paid by the public treasurer, and his expense was defrayed by the money paid for concessions of water. This amounted, in the time of Frontinus to 250,000 sesterces[5] annually; this revenue was often taken for other purposes. The Emperor Domitian used it for his own benefit; Nerva caused it to be returned to the public treasury. The expenses of the supply of water for Imperial properties were paid from the public treasury, as were also those for pipes and all expenses relative to the maintenance of the aqueducts, the water tower and reservoirs, or public fountains. The maintenance of the aqueducts was the especial care of the administrator, for they were exposed to many and frequent causes of damage, which it was necessary to foresee and prevent. Accidents were occasioned by the ravages of age, by exposure to intense cold and heat, by the violence of tempests, through the fault of badly-constructed work, and by the dishonesty of the proprietors of the fields adjoining the aqueducts, who fraudently caused the water to escape from the channels in order to irrigate their land. Those portions of the aqueducts supported by arcades suffered most from the effects of age and the violence of the mountain storms. Where the arcades crossed the rivers the foundations were much exposed to the violence of the currents in times of floods. The channels in masonry along the flanks of the mountains were exposed to land-slides and many other causes of accident. It was necessary to bring to the execution of all work required to prevent these accidents, and the consequent interruption of the supply of water, great activity, and to have the work performed with great care. The channels underground suffered less, not being exposed to the effect of intense cold or heat. Accidents to the channels could sometimes be repaired, while still maintaining the supply of water, by carrying it across or around the break, through a temporary channel made of lead pipes held at the proper elevation.

A frequent obstruction to the passage of the water was the gradual deposit of mud on the bottom and sides of the channel, which formed in time hard and thick incrustations, and which gradually narrowed the channel till the passage of the water was finally entirely prevented. Sometimes the mortar would drop out and permit the water to escape, which would damage the walls of the channel and the masonry supporting it. Only those repairs that were absolutely necessary were permitted during the heats of summer, so as not to interrupt the distribution of water at the season when its use was the most required. Spring and autumn were recommended for this work as the season most suitable, when the fresh masonry would not be exposed to the intense cold of winter, which would freeze the mortar before it was "set," nor would it be exposed to the heats of summer, which would absorb the moisture in the mortar and thus prevent it from forming a solid mass with the stones; for intense heat is as injurious as intense cold to fresh mortar. Moreover, there is no work which demands as much skill, precision and care as masonry required to prevent the escape of water; each piece must fit exactly according to the rules which most masons understand and few observe. By preparing in advance all material required, and working with the greatest celerity, the passage of water was interrupted for the shortest possible period, and by working on but one aqueduct at a time, the city was not deprived of too great a quantity of water at once.

The administrators were empowered by the Senate, when repairs were to be made to the aqueducts, to procure earth, clay, stone, sand and wood from the adjoining fields and have them transported across the fields if necessary, the damage having been previously appraised. Fifteen feet were ordered by the Senate to be reserved on either side of the channels, no buildings or trees being permitted within that space except where the aqueducts were entirely under ground, when the space was reduced to 5 feet. This law had fallen into such disuse that proprietors often inclosed this ground within their fields and used it for their own convenience, building and planting upon it as they pleased, and making roads over it, and even going so far as to prevent the employés of the administrator of the water supply from visiting those portions of the aqueducts, and thus these constructions were, from want of proper and timely attention, gradually destroyed. The real and prime cause of the destruction of the aqueducts was the negligence of the administrators intrusted with the care of the preservation of these magnificent testimonials of the civilization of ancient Rome. The workmen appointed to attend to the repairs, profiting by the negligence and following the examples of their masters, neglected their allotted work and attended to private affairs. Pliny tells us that long before his time the city was deprived of the benefit of the water from the Marcia, the Julia and Vergo aqueducts: that the proprietors of the land adjoining the aqueducts had turned all the water to their own use; nevertheless, the water from these aqueducts continued to figure on the public register as amounting to 2,242 quinaires daily, exactly as if it were regularly received and distributed.[2]

It is evident from what has been said in regard to water supply that modern cities have not advanced beyond ancient Rome; indeed, in regard to abundance, no city has ever yet even contemplated supplying to its inhabitants such a large quantity. There was an abundant supply for every purpose: that which was used for drinking purposes was brought from a great distance, and its freshness was retained by bringing it through conduits of stone and keeping in covered reservoirs, where it was exposed to the action of the air, and at the same time protected from the rays of the sun. Great care was taken to prevent any pollution. As to the abuses in ancient Rome of the public water, it is not the place of the writer, nor his object, to remark upon them, or to make any comparison with those of modern times. Many of the larger cities of both the Old and New World have recently imitated ancient Rome or are now contemplating so doing, by procuring their supply of water from long distances, from localities removed from all causes of pollution, and bringing it to the inhabitants by means of gravity through aqueducts.

WHILE the New World is busy with canal projects, from Chagres to Choptank and Choptank to Cape Cod, no less interest in this sort of engineering enterprise is felt in Europe. Among the lately revived undertakings is the old one for connecting the North Sea and the Baltic. The first practical steps toward severing the Danish peninsulia were taken just a century ago. The Eider empties into the North Sea below Tonningen, and the deepening of that stream in 1784 went far toward opening a waterway from Kiel, on the Baltic. During the past fifty years the project of a regular ship canal has for time to time been broached; and now Germany, having possessed herself of Holstein, is in a position to build it within her own domains. The canal, of course, would have military as well commercial aims, as it would enable the Baltic and North Sea squadrons of Germany to promptly reinforce each other

3. It will be remembered that *familia* (a family) means properly, the servants belonging to a common master.
4. Fr., ch. cxxiii.
5. This amounts to but $8,500 of our money, but the great difference of relative value must be taken into consideration.

* Frontinus, ch. cili.
† Id. cili.

1 Frontinus ch. cx.
2 Pliny, lib. 31, ch. xxv.

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A CONTRACTOR in Philadelphia has been causing a small riot. There are, as is well known, a great many narrow streets in that city, although there is nothing very Oriental about them; one of these streets is Bread St., 18 feet from house to house. The manufacturers in the street wished more width, and a party of men in the employ of contractor Alex. Armstrong proceeded to "widen" the street by simply curtailing the pavement on each side, in other words "robbing Peter to pay Paul." The proceeding was received in a belligerent fashion by the householders, and war rages in Bread St.

WRITING UPON BAKED CLAY TABLETS.

[From the *Moniteur Industriel.*]

Tablets of unglazed baked clay, from their inalterable character and cheapness, are better adapted than any other material for use as labels in cellars and in the garden, but owing to their porosity it is very difficult to write upon them. M. Wiencke proposes to remedy this defect by soaking the clay labels in a solution formed by adding a little acid to new milk, or milk with the cream upon it, and then filtering the precipitate formed. After the tablet thus treated is dried, it can be as easily written upon as if it were a slightly sized paper.

A PROPOSED N. Y. AND PENNA. R. R.

O. H. Ostrander, C. E., has recently completed the surveys and handed in his report upon a new railroad line, intended to connect Middle and Southern Pennsylvania and Central New York. As proposed, the line is to start at Danville, Pa., and thence north to Bernice, in Sullivan County, N. Y. The entire line is 53 miles long, no tunnels and generally light work. According to the report made, this route is the shortest and best connection between Central New York, and Philadelphia, Baltimore and Washington, and brings this section of New York 38 miles nearer the Shamokin coal fields than by the most direct line of railroad at present operated. The estimate of cost is $1,825,000.

THE ARLBERG TUNNEL.

The tunnel on the Arlberg Railway, which is expected to become such an important exit for Austro-Hungarian produce to France and Switzerland, is rapidly approaching completion. The tunnel is nearly 6½ miles long.

From the *Moniteur Industriel* we make the following extracts regarding the progress of work to the end of last August. The average number of workmen daily engaged upon the two sections of Landeck-Saint-Auton and Langen-Bludenz, at the date mentioned, was 7,926.

The material removed amounted to 229,273 cu. yds., and the masonry laid to 49,843 cu. yds. At the western end eight boring machines are at work; the main daily progress made by these machines is nearly 20 ft., taking the average of 81 days' work. At the eastern end four machines are in operation, making an advance of 19 ft. as the average of 27 days work.

The total distance between headings was on Aug. 3, 3,673 ft.; on Aug. 31 this had been reduced to 2,690 ft. The portion of the tunnel in condition to be operated by locomotives was, on Aug. 31, 11,545 ft. on the west side, and 7,872 ft. on the eastern side.

THE NEW ENGLAND WATER-WORKS ASSOCIATION.

From the Transactions of this Association for 1883 we learn that the present organization numbers 48 active members, and 9 members of the special class, of firms engaged in the manufacture of materials used in the construction of water-works. The President for 1883-84 is Frank E. Hall, of Worcester, Mass., and the Secretary is Robert C. P. Coggeshall, of New Bedford, Mass.

After an unsuccessful attempt in 1877 to start a similar association in New England, the scheme was abandoned until 1882, when a permanent organization was effected at a meeting held in the Essex House in Salem, on Oct. 11, with 13 active members; the second annual meeting was held in Worcester, Mass., June 21, 1883; the last meeting at Pawtucket, R. I., Sept. 19, 1883; the third annual meeting will be held in Lowell, Mass., June 19 and 20, 1884.

The purpose of the Association is the "promotion and advancement of knowledge, scientific and practical, in all matters relating to the construction and management of water-works." Any Superintendent, Registrar, Secretary, Treasurer or Engineer of a water-works is eligible for membership. Also all firms engaged in furnishing materials for the construction and maintainence of water-works may, as special members, take part in the discussions, but cannot vote. For active members the initiation fee is $5, annual dues $2. Special members $10 admission fee as members, no dues.

The present copy of the Transactions contains a lengthy and interesting discussion by the members upon the "prevention of waste in service pipes," too long for insertion here, but we have no doubt that parties interested can obtain copies by application to the Secretary.

THE CONDITION OF THE IRON TRADE.

It is now four years since the iron trade has been called upon to encounter any very serious problem; but during the past twelve months a declining tendency has been at work, the result of several influences, chief of which has been the excess of capacity, over the market requirements. One year ago 443 furnaces were in blast, but at this time the number is only 334, and within 30 days it will probably be reduced by 10 or 15 more. The present producing capacity is a little below 90,000 tons per week, as against a capacity of from 92,000 to 93,000 tons three months ago. The number of anthracite furnaces in blast declined from 157 a year ago to 117 at present. The number of bituminous furnaces a year ago was 128; present number reported in blast, 114. To what extent the high price of anthracite coal affects the blowing out of more anthracite than bituminous furnaces is a question of great importance to the anthracite iron interests.

The probable future course of the pig-iron trade is a matter of much uncertainty. Southern irons are coming into competition with northern irons, more in western than in eastern markets, and that competition is likely to increase, as northern and southern capital seeks investment in southern coal and ore fields, and as the cost of transportation from southern furnaces to northern markets decreases. There is a fair field for capital in southern furnaces, and decreasing opportunities in the north.

Most of the furnaces now out will remain out permanently. Several new furnaces are projected in the South, and from the encouragement received, it is fair to presume that the advantages offered by the South will be utilized, and that production there will increase, and production elsewhere decrease.

A careful review of the iron situation does not justify all of the gloomy predictions indulged in iron circles and by the trade papers. The causes of the present depression are, to a certain extent, artificial; considerable business is held back on account of the declining tendency. A great many buyers say they are ready to purchase largely as soon as prices have reached bottom limits. Requirements are large, East, West and South; consumers are running with very short stocks; makers are endeavoring to adapt supply to demand. Stocks are comparatively low in first and second hands. All of these facts point to the probability of a sudden expansion of demand, as soon as consumers are certain that lowest prices have been reached. Present producing capacity is equal to 4,700,000 tons.

Foreign irons are coming in, in trifling lots. The competition of foreign irons may be set aside as a serious factor in the iron problem. The present producing capacity will cover present requirements. It is safe to assume that the demand will not recede, and hence the inference that present prices are the lowest probable is the only correct one under the circumstances, and upon this inference consumers seem now to be acting. Within a week or two some large sales have been made, and a number of inquiries have been made for large lots of forge. Foundry requirements are being provided for from week to week. Prices range from $19 to $22 for foundry, $18 to $20 for forge. The latter is strong and the former weak.

In Western Pennsylvania the absorption of furnace stocks has brought inquiries into the market for supplies for the next 60 to 90 days. In the Hanging Rock region a fair inquiry prevails, and numerous large transactions are reported. In Chicago and St. Louis buyers are looking around more actively for stocks, and both foreign and Southern irons are being bought with more freedom. Buyers generally seem to be acting upon the knowledge that pig-iron prices have reached the lowest probable limits, and that, while an upward tendency in prices is scarcely *probable*, it is *possible*. This is a wise conclusion and one upon which consumers are not always fortunate enough to act. But little is done in foreign Bessemer iron, and only trifling lots of spiegeleisen are reported as moving during the past two or three weeks.

The production of the Lake ore region this year shows a falling-off, as compared with last year, of 555,015 tons; the figures being 1,766,103 and 2,321,116 tons.

The importations of foreign ores up to September 1st show a decline of 8.6 per cent. as compared to importations last year, the figures being respectively 339,076 and 310,054 tons, exclusive of Canadian ores. Probabilities point to a further decline in the price of ore, for two reasons: first, the increased stocks in consumers' and jobbers' hands, and, second, the opening of additional ore fields.

The bar iron interests are suffering from overproduction, for which there seems to be no remedy other than the disagreeable one of restriction. Those mills turning their product into specialties are not suffering, but those obliged to manufacture plain bars find a bitter competition which is resulting here and there in restriction to single turn. Bar iron sells at $1.75 to $2.15 per 100 lbs.

Nails have declined to $2.85 to $3, in the East and West, and to $2.65 to $2.80 at Pittsburgh bottom prices.

The most fortunate mills rolling iron are those on plate, tank, sheet and structural shapes. The engineering requirements are large, and likely to continue so. Bridge, ship, boat, car and locomotive work is in abundant supply, and all the railways are purchasing freely to complete or extend their facilities and equipments. Whatever may be said of the falling off in the construction of long lines of railroad, it can be asserted that there is considerable activity in the completion of short lines, and in supplying facilities for the accommodation of the increasing traffic. The favorable condition of roads is shown by the September earnings of 38 reporting roads, with 38,678 miles of road, as against 34,425 miles last year. Total earnings, $20,983,324, this year, as against $18,755,622 for same time last year, an increase of 12 per cent. in earnings, and 13 per cent. in mileage. The reported earnings of 36 companies for 9 months this year are $144,082,869, as against $127,558,038 last year, with a corresponding mileage of 38,325 miles this year and 33,401 last year; an increase of 13 per cent. in earnings and 15 per cent. in

mileage—a fact which anti-monopolists, grangers, demagogues, and aspiring politicians should carefully consider.

The indications in stock circles, as far as it is safe to rely upon indications, point to the probability of an early improvement in legitimate railway securities, and to an increased investment upon the part of the general public in new enterprises. While the iron trade itself is suffering from a very marked depression, the probabilities are in favor of an ultimate improvement, though it may be delayed for a few months.

THE ENGLISH ASSOCIATION OF MUNICIPAL AND SANITARY ENGINEERS AND SURVEYORS.

Vol. IX. of the Proceedings of this Association has been published, and embraces a list of officers and members, the towns represented and a report of meetings for the years 1882-83.

Among the numerous papers read is one upon the Manchester, Bury and Rochdale Street Tramway, which is interesting as giving the most approved and latest English practice in the construction of street railways. The Manchester Tramway is upward of 44 miles in total length. The rail used is known as the Gowan rail, it weighs 93 lbs. to the lineal yard, is 7 in. deep, 7 in. wide at the base and 3 in. wide at the top, and is made of solid steel. The head of the rail near its inside face contains a groove about ¾ in. deep in which the flange of the car-wheel runs. The gauge ties are wrought-iron angles, located 8 ft. apart and the rail is secured to the upper face of the tie by wrought-iron clips, two of which are riveted and two secured by bolts on each tie; a ¼ in. bearing-plate is riveted by a single rivet to the tie under each rail. The rails are connected by slightly convex steel fish-plates with four bolts to each joint.

Wooden ties or stringers are not used at all. The base of the rail rests directly upon a bed of concrete about 6 in. thick, composed of seven parts broken stone, sand and gravel and one part Portland cement; the concrete extends over the entire tramway, and 18 in. outside the rails on each side. The paving between the rails is granite, the blocks setting flush with the top of the rail. The rail itself is costly, being difficult to roll. The groove in the head is cut out after the rail is partly formed in the mill. The present cost of the Gowan rail in England is from $45 to $50 per ton. This tramway has been designed for steam traction with an engine of the Wilkinson type. The gauge of 3 ft. 6 in. is one newly adopted; 4 ft. 8½ in. is the rule in the majority of English towns, the actual total mileage being 600 miles; the total mileage of the narrower gauges is 220 miles.

In the discussion upon this paper a number of the members present regarded the "girder rail" as the type of the future rail throughout the kingdom, and the difference now existing in the gauge of tramways as a feature to be deplored and likely to cause trouble. Steam traction is also expected to entirely replace the horse railways of the day; the engine to be charged with steam or superheated water at regular stations along the line as is now successfully practiced at Dusseldorf, in Germany.

The Wilkinson Tramway Locomotive referred to in the paper just quoted is itself especially described in a paper read before the Liverpool Engineering Society April 25, 1883. The boiler is vertical with an internal fire-box, giving an annular water space all round. The crown-plate is perforated with a number of holes, and into each is fitted a hanging tube, closed at the lower end. These tubes, full of water, of course, when the boiler is in action, are only ⅛ in. thick, and being exposed to the most intense heat of the furnace are extremely sensitive generators of steam. To prevent their boiling dry another tube hangs loosely in each, fitted with a conical mouth-piece, with three wings on the underside of the cone to preserve an annular space between the top end of the large tube and the underside of the cone. The smaller tube descends to near the bottom of the main hanging tube, and when in action the heated water in the tube, following the natural law (the difference in specific gravity between hot and cold water), ascends through the outside annular space and is replaced by a current of cooler water passing down the inner tube. This circulation brings every particle of water rapidly in its turn into close contact with the fire in the furnace. The tubes being fastened only at one end can expand and contract without in any way affecting the integrity of the boiler. In the "uptake" or chimney in the center of the boiler is a cast-iron box or superheater, into which is led the exhaust steam from the two engine cylinders, and this steam, being highly rarified and superheated before its escape up the chimney, by its velocity causes a strong artificial draught in the furnace.

The engine used with this boiler is of the ordinary inverted vertical type, with link reversing gear, steam brake, etc.

The present number of the Proceedings contains a number of other valuable papers, among which we might merely mention the following: "The Ventilation of Sewers and House-drains;" "The Separate System of Sewerage, as carried out at Reading;" "The Supply of Electricity by Local Authorities;" "The Abingdon Water Works," and "The Warwick Water Supply."

The work is for sale by E. & F. N. Spon, 35 Murray St., N. Y., price 7s. 6d.

CORRESPONDENCE.

FORM OF NOTE BOOK.

UNIONTOWN, Pa., Oct. 20, 1883.

EDITOR ENGINEERING NEWS:

Several inquiries for forms of field books having appeared in your valuable journal lately, I desire to submit the following transit book form used by me for a number of years:

STATION.	Distance.	Degree of total curvature.	Deflection.	Cal. course.	Mag. course.
P. T. 13	300.0	.....	6° —	N. 20° 13′ C.	N. 20° 15′ E.
12		.....	4° —	.....	.....
11		.....	2° —	.....	.....
P. c. 10		12° — 4° R. for		.....	.....

I think the above form embodies all that is necessary either for preliminary surveys or for location. On preliminaries the third column, of course, is left blank. Some engineers prefer a column for tangent distances, but these can be placed on the opposite page, or another column might be added, but the objection is that it increases the size of the book, making it inconvenient to carry in the pocket.

ENQUIRER.

BOOK NOTICE.

"A TREATISE ON CRANES. Descriptive particularly of those designed and built by the Yale & Towne Mfg. Co.," by Henry R. Towne, Mechanical Engineer.

This work, while it is avowedly intended to describe and advertise the especial forms manufactured by the firm with which the author is connected, is without doubt one of the most valuable technical treatises that has of late appeared. The subject of which it treats is one that has been almost wholly ignored in the past; and the meagre existing literature treating upon it, is out of date; left far behind in the rapid and radical advance of modern practice.

Mr. Towne, an acknowledged expert, is well qualified for his task as an author; and so rarely do these gentlemen appear in print, that those interested are to be congratulated upon the present production.

The work commences with a general survey of the subject of cranes, including an enumeration of the principal forms in which they are used and a definite system of nomenclature of parts and types, and concludes this first part of the book with a study of the most important elements of mechanism employed in crane construction.

The value of the book, aside from its detail and description of the most excellent machinery made by the Yale Company, lies in the hints and suggestions that can be gleaned from the thorough method of reasoning adopted by the author in explaining why certain forms were preferred. In short, the entire work is the outcome of extensive experience and patient, practical experiment. The theory throughout is backed by practice under circumstances and conditions favorable to the best results. That the incentive was commercial success has only been to the advantage and completeness of the experiments made, as evidently neither labor nor money were spared.

The investigation upon the subject of the suspending hooks is exhaustive, and is the result of a thorough examination of the subject by some of our most prominent engineers; the formulæ given are believed to be the most reliable and complete now in use.

Chains vs. ropes; chain-wheels vs. drums; friction and safety clutches; traveling cranes and the devices for moving and keeping them square; frames, trucks, girders and crane foundations, are all treated upon, and sound reasons given, and practical suggestions made controlling their use and adaptation under different condition.

The last part of the work is devoted to a detailed illustrated description of the many forms of cranes, etc., built by the Yale & Towne Manufacturing Company, showing the great variety of uses to which they can be applied.

OBITUARY.

RICH. SIG. CARL. WERDERMANN.—The death of this well known electrician is announced. He was born in 1828 in Silesia and had served in the Prussian artillery. He established himself as civil engineer in Paris. He is principally known for his invention of the lamp bearing his name and for his claim to the Jablochkoff patent. He was also the first to work the idea of the transmission of power by the Gramme Machine.

PERSONAL.

MR. J. M. SEARLES has been employed to run the levels and do the engineering work of the Vicksburg water-works.

JOSEPH HASIE, chief engineer of the Fargo & Southern, is in Fargo superintending the building of the bridges across the Wild Rice road.

ENGINEER G. M. WILLIS, of Minneapolis, was in Ashland lately. He has charge of the engineer corps of the Minneapolis, Sault Ste. Maria & Atlantic Railway, who have started to run a preliminary line from Florence northeast to the Sault, a distance of 150 miles.

THE KANSAS CITY ENGINEER.—The Kansas City *Times* of the 23d says. A change in the city engineering department went into effect yesterday, by which the place of the superintendent of construction is to be filled hereafter by Mr. J. W. Nier, the gentleman who for some time had charge of the improvements in the Missouri River at this point. Mr. Samuel Rockwell, the former superintendent of construction, resigned his place to accept a position as assistant chief engineer for the construction of water works in St. Paul, for which city he left last evening.

OLD WORLD LABORERS.

PITTSBURGH, Pa., Oct. 24.

Joseph D. Weeks, secretary of the Western Iron Association, arrived to-day from Europe, where he has spent the past four months in investigating the iron industries and their ramifying influences upon capital, the laboring classes and national prosperity, and their direct and indirect sympathies with American enterprise. Much that he has learned during his foreign tour will be incorporated in a report to be submitted to the Department of the Interior.

NOT EARNING LIVING WAGES.

His report so far as it concerns the laborers in England, France, Belgium and Scotland, is very gloomy. The laborer, he says, manages to exist—he cannot be said to live when living is an expression of life's fulfillment of content. The wages are lower than are paid here, while food is higher.

About one-third of the puddling furnaces in the North of England are idle. Mills are running on part time and exercising but a partial capacity. In England arbitration is rapidly assuming the position fo a practical solution of labor troubles. Trade unions are strong and flourishing, and have ststability, financial standing and dignity that they do not attain in America.

THE CENTRAL PACIFIC SNOWSHEDS.

On the topmost height of Red Mountain a slight prominence, that looks no larger than a bushel basket, can be seen, which is a telephone station established by the Central Pacific Railroad Company. This is a house occupied by two watchmen, who are on the lookout for fires in the snowsheds. They can take in the whole line of snowsheds with their natural sight and by the aid of glasses. If they observe a fire in or near the sheds on any part of the line, they immediately notify the station at Cisco by their telephone line, and forthwith the information is sent by telegraph to the railroad station at Sacramento, and in a minute or two the order is sent up the line to Blue Cañon and the Summit, where fire trains are constantly on duty, to proceed to the point where the fire is prevailing. The train consists of a locomotive with two tank cars, filled with water, which is thrown with hose by a steam force pump. When the fire trains are sent out they have the road, all other trains near the point of danger being stopped. The services of these fire trains are frequently called upon, but they are so prompt in action that they generally subdue the fires before much damage is done. The system is as near perfection as can be made; so that any great destruction of the sheds is now nearly impossible.—*Reno Gazette.*

NEW PATENT LAW OF ENGLAND.

By an act of Parliament, taking effect January 1, 1884, the laws relating to patents for inventions, trademarks, and designs in England have been consolidated and improved so as, in the main, to incline more favorably than heretofore to inventors.

In lieu of patents running, in the first instance, for three years, they will run for four years, and instead of the stamp duties of £50 and £100 being payable, as heretofore, before the expiration of three and seven years respectively, such fees may be paid by annual installments, commencing at the fourth year and beginning at £10 yearly. This is much more favorable to inventors, as it enables them to drop the patent at any time, and relieves them from the necessity of paying large sums in advance.

Another very great improvement is that instead of the tax being £25 on applying for the patent it is now only £4. All the papers may be amended at any time before the patent is sealed. Three months, or longer, as the case may require, is now allowed than formerly was the case in which to file complete papers. If at any time default is made in any of the payments, an extension of time for three months is granted on reason therefor being shown. Only the inventor, or inventors, if there be more than one, may obtain a patent. This is quite a step in advance, as heretofore any one who first introduced an invention in England might obtain a patent to the exclusion of the rightful inventor. This means of fraud is now abolished, and only the real inventor or his legal representative can secure the patent. Each applicant is examined by one of a corps of examiners to see if the application is in proper form, if the invention is properly described, if the title properly discloses the invention, if there are any conflicting applications on file, etc. This examiner reports to the "Comptroller General of Patents," who decides in accordance with the facts as ascertained, and from his decision an appeal may be taken to one of the law officers of the crown. The entire system is under the control of the Board of Trade, who are empowered to make such rules and charge such additional fees on the several steps as they see fit. Applications may be opposed at stated times by interested parties, and interference proceedings are provided for somewhat similar to the method in vogue here.

The technicalities and provisions and requirements of the new law are greater and more intricate than heretofore, so that it is necessary to be more circumspect in the preparation of the papers. The several steps have to be advertised. While patents are to be granted in the first instance, subject to the several requirements and of the payment of annuities for fourteen years, a further extension of from seven to fourteen years is obtainable. Should a party file an application in fraud of the true inventor provision is made whereby the true inventor may stop such application and secure his rights.

Until the new law is put into practice it cannot be said with absolute certainty what the entire cost of a patent will be. It will thus be seen that the new law opens up to American enterprise a large field heretofore practically closed to it, and inventors and manufacturers will doubtless find it largely to their advantage to avail themselves of this liberal law.

A COMMON MERIDIAN.

[BY CABLE TO THE HERALD.]

ROME, Oct. 24, 1883.

The report of the committee of the Geodetic Association was presented at a general meeting of the Conference yesterday, and adopted after an animated debate. The report favors the universal adoption of the Greenwich meridian, and also recommends as the point of departure of the universal hour and cosmopolitan dates the mean noon of Greenwich. The Conference hopes that, if the whole world agrees to the unification of longitudes and hours by accepting the Greenwich meridian, England will advance the unification of weights and measures by joining the Metrical Convention of 1875. The government of Italy will be requested to officially communicate the foregoing action of the Conference to all nations.

PLANS OF THE CONGRESS.

This scheme of a prime meridian contemplates a readjustment of the standard of time throughout the civilized world. This part of the scheme may be thus summarized:—

1. To establish the standard time which may be common to all people throughout the world for all common as well as scientific purposes, this standard time to be known as cosmopolitan time.

2. One particular meridian to be selected as a time zero and first meridian, the time to be properly determined by the sun's meridian passage.

3. Twenty-four secondary or standard hour meridians to be established, fifteen degrees or one hour distant from each other.

4. The standard hour meridians to regulate time in all places of the earth's surface.

5. Local days to commence twelve hours before and twelve hours after the sun's passage over each of the standard meridians, the local days to be designated by the letters of the twenty-four meridians which determine them.

6. Each town of importance to have a public time signal station electrically connected with a central observatory for the purpose of receiving and disseminating standard time with precision.

7. All railway and local public clocks to be connected electrically from the public time signal stations.

A SUBMARINE PROFESSIONAL.

A reporter of the Cincinnati *Enquirer* lately interviewed a professional diver, with the following result. In answer to a query concerning the best armor used his reply was:

"Well, some use one kind and some another, according to fancy, but they are all alike in general principle. A few years ago the diving-bell was used for all purposes; it's on the principle of an inverted glass—carries down the air, which pushes away the water, the whole thing being fed from above by a pipe. But they're only good for shallow water. One has been invented that is fed by other small buckets that are hauled down and the air emptied into the bell, the hot and used-up air being let out through a cock. Men can work in them about three hours at a stretch, rest three, and then go down again. The bells cost a small fortune, and are now superseded to a great extent by armor. A good, first-class armor costs about $500. Some divers won't trust other folks, and own their own rigs; others, again, wear those provided by the wrecking company. The rig now used shuts you in complete, except your hands; the lower part is generally of sheet India-rubber, covered on both sides by tanned twill; the breastplate is copper, and is fastened on by screws. On some breast-plates there is a valve, so the diver can let out air or force it in, and so make himself light or heavy. The neck of the breast-plate fits on the helmet that covers the head, and this is pierced with three bull's-eye windows. Into this runs the tube through which is pumped your air supply. Besides this, you have a life-line to jerk if you want to be yanked up, in case anything goes wrong. On your back and breast hang two weights of about forty pounds each, and on your soles are forty pounds more, so you could go down with a rush if so desired.

"It depends upon the mud how deep you can go with such an armor. Fifty or sixty feet is enough for me, but I've been down deeper than that. The best diving on record is that of a chap named Hooper. He went down to a wreck off the South American coast to a depth of over 200 ft., and worked forty-two minutes at one time, going down seven times in all. But a man can't do that and live long; 150 ft. is the greatest depth a man can safely work, and at 200 ft. the pressure on him is eighty-seven pounds to the square inch. In Europe the Fish Commission hired some men to go down and collect herring eggs—something like going a berrying at the bottom of the sea. Well, they went down in the Firth of Forth in 100 ft., and what's more, got the eggs. When Captain Eads was building the St. Louis bridge, in 1870 the greatest depth worked by men in the cylinders was 110½ ft. below water level. They stood fifty pounds to the square inch, but when it got to sixty pounds a good many of the hands were taken with paralysis.

"The pearl and sponge divers in the Mediterranean Sea, Bahama and other places, all now use armor, as they can stay down so much longer.

"It depends upon the water about seeing. Ordinarily you have light enough at 40 ft. to see your way about, and in Southern waters you can see well 60 or 70 ft., everything being as clear as possible. But they have the electric light now, so a diver can take it down to almost any distance from the surface. In building the Mississippi Bridge we used candles in the cylinders, and under a pressure of 100 ft. they would burn down about three times as fast as they would ashore, and at 80 ft., when you blew the candle out, it would light right up again. The experiment was tried at 108 ft., and thirteen times the candle was blown out, relighting itself immediately; so you see pressure is a curious sort of thing."

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

BY J. JAMES R. CROES, M. AM. SOC. C. E.

DLXXIII.—BELLEVUE, O.

(*Continued from page* 496.)

Bellevue, Ohio, in lat. 31 39 N., long. 82 30 W., is on slightly rolling ground between a prairie on the east and black swamp on the west.

Settled in 1815, it was incorporated a city in 1851.

Water-works were built by the city in 1873, after plans of Mr. McReynolds, of Cleveland, taking the supply from surface water by a ditch draining a large extent of prairie land and terminating in a reservoir made in excavation and embankment, covering 15 acres, and containing 200,000,000 gallons. The reservoir is on the same level as the city, and the water is pumped into a stand-pipe by two Knowles steam pumps, one 10 by 16 inches, the other 16 by 24 inches.

Distribution is by 2¼ miles of wooden pipe of 10 to 4 inches diameter, with 12 fire hydrants. The number of taps is not given. Service pipes are of wrought iron.

The population in 1880 was 1,432. The daily consumption is not known.

The works have cost $38,000. The bonded debt is $36,000 at 8, 6 and 5 per cent. interest. The expenses in 1882 were $965.26, and the receipts $1,095.31.

The works are managed by three trustees, one being elected each year. Amos Woodward is President, and Gurdon Woodward Secretary.

WORK ON THE NEW TAY BRIDGE.

[From the London Times.]

As is nearly always the case with bridge work in the tidal rivers, difficulties withthe river bed, neither anticipated nor prepared for in the plans of works, have been encountered. More may yet be met with, but the very capable engineer in charge is of the opinion that the builders now know the worst they have to face. A triumph over the uncertain weather, which so delayed the building of the first bridge, has been gained by the huge pontoons on legs which are used for founding the piers. Those "quadrupeds," two of which are now at work, were quite an experiment on a stormy river like the Tay, but they have proved very successful. A "quadruped" consists of a large pontoon with a leg on each corner. The pontoon is floated into position, and the legs are then allowed to slide down through the pontoon till they touch the ground. Instead of being afloat the pontoon is now fixed to the ground, and by hydraulic jacks is raised out of the water upon its legs, and becomes a stationary platform. From this platform the work of laying the piers is carried on—the cylinders being lowered into their places through two large square holes in the pontoon. After the cylinder has been put down the mud or sand below it is excavated by means of a mechanical digger. It consists of a large iron trough, weighing two a half tons, the bottom opening downward. The digger is allowed to drop swiftly into the sand, where it buries itself, and on being drawn up by the crane the bottom closes automatically, and in favorable conditions it lifts as much as two tons of sand. While this process is continued the foundation on which the cylinder rests is lifted away. The cylinder then sinks by its own weight. Guide bars insure that it sinks perfectly vertically, and from the arrangements there is no possibility of its going off the plumb. As the cylinder sinks down rings of iron are added to the top. The efficiency of the standing platform is felt not only in defying the weather, but in enabling the engineers to lay the piers in their exact places—a

work that was almost impossible from a movable platform at the mercy of the wind and tide. The power of the digger in the work of excavating easily disposes of all obstacles but boulders and very hard clay, which have to be removed by ordinary processes. The foundations of the piers are being laid with the utmost care. Besides being much broader they are deeper than the foundations of the disused bridge. For some of the foundations already laid there are from 24 ft. to 30 ft. of iron cylinder sunk in the river bed. A third "quadruped" of larger dimensions than those in use is being built at Dundee, and a fourth is in course of construction at the contractor's Glasgow works. No fewer than nineteen of the piers are now nearly finished, work going on at each side and the center of the river simultaneously and continuously day and night.

THE CANAL MANIA.

There seems to be no end of canal projects. Europe is as much interested in them as our most enthusiastic American engineers. The *Journal des Debats*, of Paris, publishes a long account of the measures that have been taken from time to time to connect the North Sea and the Baltic. The first canal enterprise was proposed in 1571. Within forty years many projects have been formed. According to the plan now most likely to be adopted the canal will run from the Elbe at a point between Brunsbuttel and St. Margarethe, pass in front of the fortifications of Rendsburg and come out in the Bay of Kiel at Holtenau. Its length from sea to sea would be sixty miles and the width at the water's edge should be 360 feet and the depth thirty feet. Bismarck on one occasion said he favored an undertaking of this work by the German Government, and this may be brought about some day. Another enterprise is commended by a correspondent of the London *Standard*, who asks whether the Atlantic passage cannot be reduced by the construction of a ship canal across Ireland from Dublin to Galway or the Shannon. The cost of deepening and widening the present canal, he says, would be small and the result would be a saving of the long journey around the southern coast of Ireland.

NEWS OF THE WEEK.

A NEW CABLE COMPANY.—Articles of incorporation of the Postal Telegraph and Cable Company were filed in the County Clerk's office in this city last week. The capital stock of this company is placed at $1,500, with the privilege of increasing it. There are 15 shares of $100 each, and the following named incorporators hold three shares apiece: Henry C. Gardiner, Luther R. Marsh, T. H. Dupuy, Andrew W. Kent, Dumont Clark. The company proposes to operate telegraph lines all over this country, with connections by cable from near Greenport, Long Island, to Penzance, England, Liverpool, London, Brussels and Paris. The main line, it is stated, will extend from New York to Binghamton, Elmira, Cleveland, Chicago, Milwaukee, Minneapolis, Portland, Oregon, Cincinnati, St. Louis, Kansas City, and Tucson, Texas.

THE annual meeting of the stockholders of the Hudson Tunnel Construction Company for the purpose of electing directors for the ensuing year will be held at the office of the Company, No. 47 Montgomery street, Jersey City, on the 5th of November, 1883, at 12 o'clock noon. Frederic B. Jennings, Secretary.

CATSKILL WATER-WORKS.—Catskill, N. Y., is building water-works. Work will begin this fall, and be completed next season. W. S. Parker is engineer; H. O. Evans and George N. Brandon are assistant engineers.

THE BURLINGTON, CEDAR RAPIDS & NORTHERN commenced last week their survey for the Northwest extension of the Pacific Division, from Worthington, Minn.

THE CANTON IRON BTIDGE CO. has just closed a contract for two iron spans, 165 ft. each, over Cedar River, in Linn County, Ia., for $9,875—fourteen bidders.

ST. CLOUD (MINN.) WATER-WORKS.—Philip Buehner, of St. Paul, Minn., received the contract for furnishing the pumping machinery, etc., for the St. Cloud Water-works. He has ordered three Gaskill pumping engines, manufactured by the Holly Manufacturing Co., Lockport, N. Y.

STRAW LUMBER.—S. H. Hamilton, of straw lumber notoriety, writes from New York city to the effect that he has been successful in securing the organization of a stock company for the purpose of manufacturing straw lumber with a capital of $500,000. Their works will be in Lawrence, Kan., and lumber for railway purposes only will be manufactured. Chas. A. Dana, the editor of the New York *Sun*, is said to be one of the incorporators.

NEW PAVEMENT.—St. Louis papers speak of a deposit of chert in the Iron Mountain, which it is thought will give that city the best pavement in the country.

$250,000 for street pavement was the ordinance offered in the City Council the other day. It proposes to pave Christian Street, west of Broad, with Belgian blocks, at $50,000; Front Street, Eighth Street, at a cost not to exceed $20,000; Fortieth Street at $50,000; Diamond Street, with asphaltum blocks, at a cost not to exceed $50,000; Locust Street, with Belgian blocks, at $50,000; Arch Street, at $40,000; Ridge Avenue, at $25,000, and Fairmount Avenue, with asphaltum blocks, the expenditure to be $50,000.—*Philadelphia Times.*

FRANKLIN & SOMERSET R. R.—The Railroad Commissioners of Maine have approved the lay-out of the Franklin & Somerset Railroad, and work will probably begin this fall.

STEPHEN L. & ANDERSON MERCHANT, cement dealers at 25 State Street, New York, made an assignment on the 23d, with about $35,000 preferences.

WINNIPEG POST-OFFICE.—The contract price for the new post-office is $122,586, exclusive of the inside fittings. The building will be 60 feet by 119 feet. Mr. J. G. Macdonald is the contractor.

LYNN WATER WORKS.—Lynn will extend its water-works this fall at a cost of over $17,000.

NEW BRIDGE.—BROWNSVILLE, TEX., Oct. 16.—Count Telfener's man Friday, Mr. Moneta, has been trying to get a site for a drawbridge over the Rio Grande.

THE WEIRS WATER-WORKS.—The new reservoir on the Doe Hill at the Weirs, N. H., will be completed by early winter. It will receive water from two never-failing springs and will supply a greatly needed want of that popular resort.

CHICAGO SEWAGE.—At a meeting of the State Board of Health, Dr. Rauch said he had examined the Chicago River and its branches and the Illinois and Michigan Canal. In July he inspected the Ogden ditch and dam, the Desplaines River and the Bridgeport Pumping Works. The fall which occurred in the Desplaines River remedied to some extent the condition of the Chicago River, by causing the flow in the canal to be taken more largely from the South Branch instead of from the Desplaines. He now recommends, however, that, on the close of navigation, the pumps at Bridgeport be operated to their full capacity throughout the entire winter. This will serve to relieve the nuisance caused by the cessation of the flow, and it will tend to prevent the pollution of the Chicago water supply, which results every spring from the washing out of the winter accumulation of sewage of Chicago in the spring. He thinks there is danger of such pollution during the entire winter, owing to the lower lake level which then obtains, and whenever a thaw or rain occurs the contents of the river flow out into the lake. He says it is intimated that the Bridgeport pumps have not sufficient capacity, and the city of Chicago should attend to the matter at once, so as to avert danger to residents along the canal, and protect themselves. The report of the secretary was accepted.

THE NEW ALBANY BRIDGE.—The Kentucky & Indiana Bridge Company was organized a few years ago, with Mr. John McLeod as chief engineer and Mr. C. Schaler Smith as consulting engineer, and all the plans, etc., have been made by these gentlemen. There will be eight ordinary piers and one circular draw tower, besides the two abutments. The average height of the piers will be about 115 feet. The approach at the south end will consist of an iron trestle, while that at the north end will be an embankment. The superstructure will consist of two spans 260 feet long, one span 480 feet, one 360 feet, one 240 feet, and two spans 185 each, forming the draw at the channel. The trusses are to be constructed somewhat after the post design. There will be separate avenues for foot-passengers, wagons and street-cars, and a single-track railway. The total estimate of the cost of the structure complete is about $1,500,000. The engineer in charge is Mr. H. P. McDonald, formerly contractor with the Henderson Bridge.

BIDS for the Barnesville bridge were awarded at New Haven, Conn., as follows: Pilling and timber to C. E. Waterhouse & Son, $1,756; masonry, E. R. & C. S. Redfield, $2,925; iron work and creosoted superstructure, Hudson River Bridge Works, of Hudson, N. Y., $3,160. The only bid for the paving was that of C. W. Blakeslee & Sons, for $875. They received the contract. The total cost of the bridge will be $8,716. Engineer Hill's estimate was $8,700.

PARSONS (Kan.) will have water-works this week.

THE LEHIGH TERMINALS—IMPORTANT CONTRACTS.—The Lehigh Valley has quietly secured an entry into Buffalo. Mr. Fred Mercur has closed several important contracts, among which one with Mr. J. E. McIntire for building 4,000 feet of double-track trestle. Mr. McIntire has also made an agreement to build the wharf on the Tifft farm canals. The cutting of these canals, comprising 8 miles of water front and involving the driving of some 65,000 piles, has also been secured by the same contractor.

THE NEW ORLEANS & MISSISSIPPI ROAD.—This road was recently inspected between New Orleans and Baton Rouge by Capt. John A. Grant, chief engineer; R. W. Rogers, of Rogers & Ballentine, contractors. A great many bridges have to be built.

MISSOURI GRANITE.—Specimens have been received at the Treasury in connection with the bid of a granite company in St. Louis on the Pittsburgh public building. It is pronounced a fine specimen of building stone.

CHICAGO & NORTH-WESTERN EXTENSION.—A line will probably be built through to the Missouri, from Redfield, D. T., crossing the Mississippi a little below Little Bend. There will likely be more building next season in Dakota than last.

THE Bangor Furnace Company of Michigan has failed, with liabilities of some $130,000. The assets are nominally placed at double the sum.

TELFENER'S PROJECT.—The New York, Texas & Mexican Road has changed its initial point from Percaderia to Matamoros. A full corps of engineers are at the place mentioned waiting to begin the survey. Some severe complaints are made as to the action of the Company toward Texan creditors.

THE MEXICAN CENTRAL.—This road (1,214 miles from El Paso to Mexico) is being rapidly built. The Southern division is complete to 96 miles, while 208 miles remain of the northern branch, and the track is being laid at the rate of 2 miles a day. The total cost of the line is estimated at $16,000 per mile, U. S. money.

THE City Council of Columbia, S. C., have decided to vote an appropriation for the continuance of the canal improvement.

THE ST. LOUIS MACADAM CONTRACTS. The bids received by the St. Louis Board of Improvements have been as follows with the corresponding contracts of last year:

Wm. Heman and Henry Stolle, $5 60 per square; contract of last year, $3 97 per square.

The same parties at $5 15 per square; contract of last year, $3 89 per square.

John O'Mara and John Bowden, $5 80 per square; last year, $4 98 per square.

John O'Mara and Pat McKennon, $5 50 per square; last year, $4 99 per square.

John O'Mara and Wm. O'Gorman, $5 per square; last year, $4 per square.

The city is divided into 16 macadam districts.

THE KANSAS CITY BRIDGE.—This bridge was to be built across the Kaw River at Sixth st., Kansas City, by Kansas City Bridge and Iron Company at a cost of $25,000. Wyandotte, which was to pay half the cost, has refused through her councilmen to sign the contract, and a great deal of indignation exists about the matter.

ST. LAWRENCE CANALS.—Sealed proposals will be received by the Canadian Government until Nov. 13th for the construction of a lock and regulating weir and the deepening and enlargement of the upper entrance of the Cornwall Canal. Also for the construction of a lock, together with the enlargement and deepening of the upper entrance of the Rapide Plat Canal, or middle division of the Williamsburg Canals. Tenders will also be received, until Nov. 27, for the extension of the pier-work and deepening, etc., of the channel at the upper entrance of the Galops Canal. For maps, plans, specifications, and other particulars, address Department of Railways and Canals, Ottawa, Canada.

RIVER AND HARBOR BILL.—The U. S. Engineer Department has reported $35,000,000 for River and Harbor Improvements.

THE POWERS OF HEALTH BOARDS.—ASBURY PARK, N. J., Oct. 19.—T. Hyer was tried to-day in the Monmouth County Court upon an indictment charging him with assaulting Health Inspector Coles, of Asbury Park, while the latter was inspecting his property. In his charge to the jury Judge Walling said that the Board of Health had no right to appoint an inspector, and no authority to make an inspection of any man's premises, except in cases where a complaint had been made, and that after a proper complaint had been made a majority of the Board of Health must make the inspection. The jury acquitted Hyer, and he will prosecute the members of the Board of Health and Inspector Cole for false arrest and false imprisonment. The ruling of Judge Walling affects every local board of health in the State.

STATE AID TO RIVERS AND HARBORS.—The State of Texas has recently purchased $160,000 school bonds of Wise County, and the Fort Worth *Gazette* mentions that this spectacle of a State investing its surplus capital in the bonds of one of its own counties, and drawing interest instead of paying it out, is a rare one. It is so, indeed, and there is good ground for the predictions of a glorious future for that mighty Commonwealth. With a surplus in her treasury, a population growing faster in numbers, productive capacity, and real wealth than that of any other state, an immense area of unoccupied lands and the shortest railroad connections between the east and west sides of Uncle Sam's territory, her prospects are

bright, indeed. If the State is at a loss what to do with its money, there will not be wanting suggestions on the subject. From the Sabine to the Rio Grande there is a coast line of several hundred miles without a single good harbor. The people of Galveston have become very tired waiting for the Government to give them a safe, deep-water anchorage, with a channel fit for ocean steamers to traverse. They are talking of undertaking a part of the work themselves. Perhaps they could obtain help from the State. It will not be long before Texas will be able to obtain from Congress a pretty liberal allowance for needful work of this kind, but, in the meantime, the cause of Galveston is the cause of the State.—*St. Louis Republican, Oct.* 17.

FLOATING BREAKWATERS.—At the late Fisheries Exhibit in England a floating breakwater was shown, made up of a line of buoys of triangular shape with two concave sides, and inclosed by strong cables. The inventor claims great economy in time and money, and a complete breakwater. The buoys are 10 ft. deep, and by their form bring into collision the waves and cause them to expend their force upou each other.

THE JORDAN CANAL.—The English people in their desire to evade the De Lesseps concessions, are looking with favor upon the Jordan project. The Jordan Valley, from near the Huleh Lake to the Dead Sea, forms a depression that gradually reaches a depth of 2,600 ft. below the surface of the Mediterranean and Red seas. The length of this slope is about 110 miles. The actual level of the surface of water in the Dead Sea is 1,300 ft. below the two seas mentioned. Depressions in the surrounding hills afford feasible outlets toward the two oceanic seas. From sea to sea the channel would be within 240 miles; and Jerusalem would be brought within 10 miles of the channel, but 2,500 ft. above it.

In a late discussion upon this scheme Canon Tristam deplored this project which would bury forever under 500 to 1,300 ft. of water many of the historic scenes of the greatest events in the world's history; and, when reminded that such a fate was foretold by the prophets Ezekiel and Zacharäh, remarked that "he was not a believer in human promoters of prophecies."

"THE best quality of charcoal," says the *Engineer*, "is made from oak, maple, beech and chestnut. Wood will furnish, when properly charged, about 20 per cent of coal. A bushel of coal from pine weighs about 29 pounds. A bushel of coal from hard wood weighs 30 pounds. About 100 parts of oak make 23 of charcoal; the same quantity of red pine 22.10, and of white pine 23."

THE deepest sea-sounding ever taken was made in the Pacific Ocean near the entrance to Behring's Straits. Bottom was struck at 4655 fathoms. The line was thrown out from the United States schoolship Tuscarora.

THE E. T. Barnum Wire and Iron Works, Detroit, have recently moved into their new factory, corner of Howard street and Wabash avenue, Detroit. It is a building 400 feet deep by 240 feet front, furnished with late and improved machinery. They employ over 700 hands, the majority of whom are skilled mechanics. In some departments they are obliged to work two gangs, running, as they do, day and night.

PALESTINE, SABINE & NEW ORLEANS.—PALESTINE, TEX., October 22.—The Palestine, Sabine & New Orleans Railroad Company organized here today. It runs from Athens, Henderson County, through Palestine into Houston County; thence through the pineries to Vermillionville, La., and to New Orleans. The capital stock is $300,000, with the privilege of increasing it to $3,000,000. The directors are: Geo. M. Dilley, J. Osement, Jas. Amsen, U. Royall, J. T. Jones, James Hand, G. E. Dilley, T. J. Gammage, John Hearne. The road from Athens to Palestine, eighteen miles, is already surveyed. That portion will be completed by April 1. There is plenty of Northern capital promised to complete the road as projected.

THE Allegheny reservoir will doubtless be extended or else a new basin built.

THE LAKE CLIFTON RESERVOIR.—The contractors for constructing this reservoir (Messrs. Donohue) have failed to carry it out, and the Baltimore City Engineer is now engaged in estimating the value of the work done.

A BID NOT ACCEPTED.—The proposal of the Maryland Pavement Company to pave Cathredral street, Baltimore, with asphalt was not accepted.

A TAILOR WHO WANTED THE EARTH TO YAWN.—Orders have been issued from the headquarters of the Northern Pacific Railroad to the effect that all employés on trains and at stations over the line must appear in uniform. A tailor is now going over the road taking measurements of the employés for their new suits, who, in order to expedite matters, sends the following dispatch to all agents: "Take off everything but your pantaloons and shirt and be on the platform when the train arrives, to be measured for uniform." Arriving at one of the new stations he jumped from the train, tape line in hand, and shouted for the agent. In response to his call a handsome young lady stepped forward, accompanied by a burly six-footer, who announced that the lady was the agent and he was her brother, and demanded an explanation of his dispatch. The tailor explained as best as he could.—*Butte Miner.*

IRRIGATING CANALS IN KANSAS.—I. T. Soule, of Rochester, N. Y., has arranged with Gilbert Bros., of Spearville, Kan., for digging and operating seventy-five miles of irrigating canal, beginning at available points on the Arkansas River—one above Dodge City, near Cameron, and the other near Spearville, and terminating near Vanity. The work is to begin at once, and the canal completed as soon as possible.

CAMBRIDGE WATER SUPPLY.—The city of Cambridge, Mass., by its Mayor, has petitioned for authority to take land in and around the borders of Fresh Pond to preserve the purity of the water, to draw down the water of the pond to any level required by the necessities of the city, and that the rights of the city as to sources of water supply be altered, increased and enlarged; also for authority to take water from Stony Brook in Waltham and store it in Fresh Pond.

THE SCIENTIFIC CONGRESS.—ROME, October 17. The International Geodetic Conference has been invited to meet with the Scientific Congress at Washington next year to discuss a proposition for the establishment of a universal meridian.

ARTESIAN WELLS IN ST. LOUIS.—The *Picayme* says: "It is worth the experiment to determine whether we can secure water from the inexhaustible supply which is coming down from the mountains above us. A well was begun onCanal street, but the death of the engineer from yellow fever in 1853 stopped it. If we are not mistaken, the water commenced to rise in the tube."

ST. PAUL IMPROVEMENTS.—The Chamber of Commerce recommends the completion with all possible speed: As most important, the Seventh street improvement; as next important, the immediate erection of the Third street bridge, and the building of the other railroad bridges over Rice, Jackson and Mississippi streets.

VICKSBURG WATER-WORKS. Mr. C. H. Sudie, engineer of the North American Improvement and Construction Company, has arrived to take charge of work.

HOUSTON (Tex.) is to have the United States Electric Light.

DALLAS (Tex.) sewer contracts have been made with Fight & Son to construct the third and fourth ward sewers for $30,000.

ANOTHER NARROW-GAUGE.—Mr. Jonathan Beard and Mr. Solliday leave for Cannelton via Leavenworth to attend a railroad meeting to be held at Cannelton Friday night. These gentlemen will be accompanied by several citizens of Leavenworth, and their object is to talk up a narrow-gauge railroad from Tell City and Cannelton to New Albany, by way of Leavenworth, and through the best agricultural section of Harrison County.—*New Albany Ledger.*

A BIG SCHEME, ON PAPER.—San Francisco, Cal., October 20.—The People's Railway Company of America, incorporated at Indianapolis, has, through its representatives, reached this point. Some of them are here negotiating for an outlet on San Francisco Bay, but with whom it is not stated. Some time ago a dispatch was received here from Visalia, Cal., that J. W. Tripp, traveling agent for the company, had organized a local board at that point, with $50,000 capital stock subscribed. Since then nothing further had been heard of the agent or company.

THE Kansas City, Springfield & Memphis Railroad was completed on Oct. 14. Trains will be running by Oct. 25.

THE Shore Line Railway, of Maine, has 10 miles of track completed.

THE returns of 19 leading railroads for the first week in October shows earnings that aggregate $3,997,381, as against $3,533,565 for the corresponding period last year, an increase of $463,816, or 13.1 per cent. on an increased mileage of $4,337.

THE ANTHRACITE COAL TONNAGE.—The official report of the anthracite coal tonnage of all the carrying companies for the nine months of this year gives the total as 23,032,529 tons an increase of 2,257,273 tons as compared with the corresponding period last year. It is stated that no suspension of production will be arranged this month, but that a slight curtailment in the output is probable in the latter part of November.

LONDON PUBLIC WORKS.—The metropolitan board of London, the present largest central administrative body of the cities included under that name, has incurred a debt for public works of £19,000,000, nearly one-half within five years. This is about as large as the debt of New York. It has schemes in contemplation involving a further outlay of £13,000,000, of which £5,200,000 is for bridges and tunnels across the Thames. The board has been asked to surrender the tax now levied on all coal coming into the city of 13 pence per ton, or 5 per cent., but will probably refuse to do so.

A NEW MISSOURI RIVER BRIDGE.—Soundings and surveys were commenced on the 17th by the Chicago, Burlington & Quincy management, for a permanent bridge over the Missouri River at Boswell, Mo., and Rulo, Neb., north of St. Joseph, to connect Kansas City, St. Joseph and Council Bluffs with the Burlington & Missouri Air Line to Denver. A temporary pile structure is now in use.

THE artesian well experiment at North Adams, Mass., does not give satisfaction thus far. The workmen are using Edison's patent in the boring and have gone down about 75 feet in two different places and struck rock. They are now trying another place and hope to succeed. The water a few miles below, at the Zylonite works, continues to flow satisfactorily from an artesian well.

READING, PA., DRINKING WATER.—For several weeks past the drinking water of this city has been so unpleasant in taste and odor that there has been general complaint by the citizens. In view of this, by order of the Water Commissioners, Water Superintendent Harper is having the water drained from the reservoir at the head of Penn street, preparatory to removing the fish therefrom. Many persons ascribe the present state of the water to the fish, and in order to test the value of their theory the fish will have to go. Both the Olinger and the Bernhart dams will have the water drawn off them as soon as it is practicable. Water from the Olinger is now being run into the Hampden distributing reservoir.

THE YAZOO BRIDGE.—Work on the immense iron bridge that is being built across the Yazoo River at Anthony's Ferry by the Louisville, New Orleans & Texas Railroad is being pushed to completion. A force of 150 men are at work on the piers for the superstructure. The caisson for the draw-span was finished on the 16th, and will be placed in position in the next two days. Pier No. 2 on the east shore is completed to a height of fifteen feet. A pontoon bridge is being constructed to piers Nos. 3 and 4 for the purpose of facilitating the handling of material. In a few weeks trains will pass over Yazoo River.

THE old Central Ohio Railroad, between Columbus, O., and Newark, twenty-six miles used, by the Panhandle and Baltimore and Ohio, between those cities proved entirely inadequate for the traffic over its rails, so the two companies leasing are building a second track alongside of the present one. All the bridges will be removed and replaced by double-track iron bridges.

DEPTH OF THE MISSISSIPPI.—A sounding of the Mississippi River back of Cairo, where the rocks have been put in to protect the bank, gives 75 feet of water. This at the present stage of the river will give something of an idea of what the Mississippi River is, as regards volume. The fluctuation is 52 feet, and it frequently rises 45 feet above its present stage, which would give a channel depth of 120 feet, and a width at those times of 45 miles.

ST. PAUL (MINN.) BIDS.—The following bids were received for grading Dakota avenue and Goffe street: Boyer & Lux, $26,265; James Starkey, $26,700; Morton & Terry, $26,900; John B. McCarthy & M. B. Farrell, $24,920. Awarded to McCarthy & Farrell.

STEEL WIRE CABLES.—The Bureau of Equipment at Washington is now experimenting with American wire, with the purpose of commencing the manufacture of wire cables at the Navy Yard in Boston, as soon as wire of the required standard is found. The English Government has succeeded in making steel cables which are as pliable as hemp, and have the advantage in weight and space occupied.

THE STEEL PEN TRADE.—The steel pen in the many types in which it is manufactured—and there are more than 1,000 different numbers—is a signal instance of triumph of mechanical skill in combining and varying the qualities of the implement, involving extreme niceties of distinction to an extent that few other industrial arts demand. Our entire annual trade in steel pens, domestic and imported, may be placed at $1,500,000, and is a steadily progressive one. The larger proportion of those sold are American pens. It is a matter of difficulty to ascertain the relative amounts disposed of in different sections of the country, pens being mainly distributed by large wholesale houses who make shipments from the East.

The chief retailers of pens throughout the country are in the stationery, publishing, notions, dry goods and hardware trade. Our own manufacturers are reticent as to their annual production, but, taking the ascertained output of Birmingham, which supplies between 15,000,000 and 16,000,000 pens per week, with that of the few manufactories in France, the one in Germany and the one in Austria—there being none in the other European States—and the leading American establishments in Meriden, Conn., Camden, N. J., and in Philadelphia, the weekly production for this

country and Europe cannot be less than from 22,000,000 to 23,000,000 pens.

CAPE COD CANAL.—SANDWICH, Mass., Oct. 23.—The charter of the Cape Cod Canal Company requires $25,000 to be expended within four months, which, considering the time occupied by the preliminary surveys left, is too short a time for judicious expenditure. The required amount, however, is nearly spent at present, and there can be little question that it will be expended before Friday, the day on which the four months expire.

There arrived at Sandwich three tugs, with two dredgers, four pile drivers, three large scows and about thirty workmen. There are about 200 men engaged, who are working day and night by electric light. More men are expected.

Electric lights are being put up along the line, so that the men work night and day in order to finish by the time required.

The two dredging machines sent to Sandwich for work on the canal would not work because of the filling up of the bar, and smaller ones had to be procured to start with. Night work with the electric light was expected to begin on the 23d.

CONSTRUCTION NOTES.—The Baltimore & Ohio will build a branch to Bridgeport, O., across the River from Wheeling, to connect with the Cleveland, Lorain and Wheeling road. A narrow-gauge railroad from Macon, Ga., to Live Oak, Fla., is being projected. The approximate difference between the two places is 200 miles. The St. Paul & Duluth Railway will soon be turned over to the control of the Milwaukee & St. Paul & Omaha Roads, to be operated by them jointly. There is a lively movement to complete the East Alabama & Cincinnati Railroad from Opelika through Anniston to Gunter's Landing on the Tennessee River. It is understood that the Grand Trunk Railway have taken into consideration the construction of a new line from Vandreuil to Ottawa under a charter granted some years ago. Rock Island has hopes of securing another railroad, the New York, Rock Island & Omaha, articles incorporating such a railway company having been filed with the Illinois Secretary of State. Everything looks toward the opening of the Georgia Pacific Railroad to Birmingham by the 17th of November. The work between the tunnel and Birmingham is almost done, and on the tunnel itself it is rapidly progressing.

THE SOUTH-EASTERN RAILWAY at Montreal has passed into the hands of the following three trustees: Duncan McIntyre, of that city, Vice-President of the Canadian Pacific; Judge Redfern, of Mount Peter, Vermont; and William Farwell, Manager of the Eastern Townships Bank, for the benefit of the creditors.

THE Bitter Root Valley Railroad company, of Montana, was recently incorporated by the following gentlemen: W. F. Sanders and Ed. Stone of Helena; F. H. Woody, R. A. Eddy, and A. B. Hammond of Missoula. It is the intention of the incorporators to build a railroad from Missoula up to the head of Bitter Root Valley. The capital stock is $1,000,000.

RAILWAY VIADUCTS.—A list has recently been compiled of the length of the principal railway viaducts in the world, the figures of which are as follows: Parkersburg, 2,150 yards; St. Louis, over the Mississippi, 1,993; Louisville, over the Ohio, 1,635; across the East River, 1,520, and the same for the Delaware at Philadelphia and for the Victoria Bridge over the St. Lawrence; Volga Bridge, near Syssian. 1,495; the Moersdyk bridge, Holland, 1,490; Pongabuda (India), 1,148; the Dniester bridge, near Kiew, 1,090; over the Rhine at Maintz, 1,038; the Dnieper at Pultowa, 980; the Mississippi, at Quincy, 980; the Missouri, at Omaha, 860; across the Weichsel, near Dirschau, 845; the Danube, near Stadlau, 775; the Po, near Mezzana-Corti, 765; the Tamar, at Saltash, 673; the Mississippi at Dubuque, 542; the Gorai (India), 535; the Britannia bridge, 480; over the Saane at Frieburg, 392; across the Theiss at Szegedin, 365.

MT. CARMEL, Pa., wants a water company.

THE SARATOGA WATER-POWER Canal Irrigation Company, of Saratoga, Pratt County, Kansas; capital stock, $350,000. Incorporators—J. Woldock and Wm. F. Gibbons, of Saratoga, Kan.; Geore T. Empey, Henry Musick and Jos. H. Rason, of New York city, and J.H. Halbrook, of Brooklyn, N. Y.

MORE NEW ROADS.—The Chicago, Burlington & Quincy Railroad Company is surveying a route from Savannah to Galena, and it is reported on what is considered to be reliable authority that the work will be commenced on the proposed line early next year. It is also asserted that the Chicago, Milwaukee & St. Paul Company will next year continue their Monroe branch from Schullsburg, Wis., to Galena and thence to the Mississippi, and that the Northwestern Company will at the same time fill up the gap between Galena and Freeport.

DULUTH WATER AND GAS.—A special meeting of the Common Council has been held to consider the gas and water-works matter. Owing to recent rains work in this direction has been greatly retarded, and the gas and water company will ask for an extension of time.

NEW RAILROAD COMPANY.—Among the corporations licensed at Springfield on the 18th was the Calumet Bridge & Railroad Company, capital $150,000, incorporators, John B. Cohes, C. R. Cummings, W. B. Howard, George A. Ives, and O. S. Garther, of Chicago. This is understood to be an organization hitherto known as the Calumet River Railway Company, which intends to build a line of railroad beginning at the Calumet River near South Chicago and running along the river to the Indiana State line. An ordinance giving the company such right of way has been ordered engrossed by the Hyde Park Board of Trustees.

MR. B. J. MCGRANN, a citizen of Lancaster and one of the most prominent and respected contractors in the State, has entered a suit in Pittsburgh against the Pittsburgh & Lake Erie Railroad Company for the principal sum of $453,372.23 and interest, swelling the sum to $580,467.57. He was the sole contractor for the construction of the road, and his claim is for work and material outside of his contract, given in obedience to the orders of the corporation.

THE ORIGIN OF "FUDGE."—This is a curious word, having a positive personality underlying it. Such, at least, it is, if D'Israeli's account thereof be authentic. D'Israeli quotes from a very old pamphlet, entitled "Remarks upon the Navy," wherein the author says: "There was in our time one Captain Fudge, commander of a merchantman, the Black Eagle, of the time of Charles II., who, upon his return from a voyage, how ill-fraught soever his ship was, always brought home his owners a good crop of lies, so much that now, aboard ship, the sailors, when they hear a great lie told, cry out, 'You fudge it.'"—*Notes and Queries.*

CANADIAN PACIFIC.—General Manager Van Horn, of the Canadian Pacific, says: "Construction is progressing finely. We are satisfied the road will be completed to the summit of the Rocky Mountains, 962 miles west of Winnipeg, the first week in November, and on the eastern work we have got to a point forty miles west of Red Rock, or 105 miles east of Port Arthur."

"Will you work all winter on the Eastern Division?"

"Yes; we will keep 9,000 men at work there. It is only a question of men and nitro-glycerine, and we are shoving them as fast as we can use them."

"When will the road be completed?"

"Two years from this month, or in October, 1885."

"Do you look for a large emigration next year?"

"We have well authenticated assurances that there will be a large Scotch and English immigration into Manitoba and the Northwest next spring; and in a word, Canadian Pacific affairs were never more prosperous, and its future more fully guaranteed."

CONTRACT LET.—Supervising Architect Hill, on the 19th opened bids for sheet copper tinned on both sides for the public building at Kansas City. The bidders were: Shoemaker, Vante & Birch, C. G. Hussey & Co., R. A. Robbins, Detroit mills; the Ansonia Company, F. J. Field, Park Bros. & Co., and R. Michael. The award will be made to the Ansonia Company, New York, at 22 cents a pound.

IOWA, SIOUX FALLS & NORTHERN.—Sioux Falls, Dak., Oct. 19.—Articles of incorporation for a new railroad company were drawn in this city to-day, called the Iowa, Sioux Falls & Northern. It is composed of wealthy men. The capital stock is $5,000,000. The incorporators propose to at once secure right of way and begin the construction of the road, which will extend from some point in Iowa, on the Illinois Central, through Sioux Falls to Jamestown, Dak., and pass through the counties of Lincoln, Minnehaha, Lake, Miner, Kingsbury, Clark, Spink, Day, Blown, Dickey, La Mouri, and Stutsman. Its length will be 500 miles. Among the incorporators are ex-Delegate R. F. Pettigrew and A. G. Seney. Stock is being taken rapidly by capitalists both along the line and in the East. The survey will be made at once; and that portion of the road extending from Sioux Fall, in Iowa, will be completed at the earliest date, in order to afford relief from discriminations imposed upon southwestern Dakota by roads now holding control of business. The new company is backed by ample capital, and is in earnest.

SPRINGFIELD & SOUTHERN.—Hillsboro, Ill., October, 19.—For some time matters connected with the construction of the proposed Springfield & Southern Railroad have been at a standstill, but the officials have, nevertheless, been hard at work endeavoring to put things in proper shape. Col. J. H. Concannon, St. Louis, has been East negotiating for the purchase of iron work. Securing right of way and raising a bonus has progressed satisfactorily in Bond County. Greenville has raised about $15,000 and secured considerable right of way. To-night a telegram was received from L. D. Saxton, manager of a large construction company which is backed by New York and St. Louis capitalists, that he had closed the contract for constructing the road. Work will begin immediately.

A TERROR TO ENGINEERS.—Columbus, Ind., October 15.—Readers of the *Enquirer* will doubtless recollect my special last spring detailing how Jacob Cook, a wealthy farmer near here refused to allow the engineer corps of the Columbus, Hope and Greensburg Railroad to make a preliminary survey across his lands by planting himself on the fence with a heavily charged double barreled shot-gun and two large navy revolvers strapped to his side, and how he held the engineers at bay for two days and nights till Col. Scott was telegraphed for and had a warrant out and Cook arrested and lodged in jail until the survey had been made, after which he became reconciled, as when the road was built it would form a valuable levee to protect his land from overflow in Hawk Creek Bottoms.

Saturday, on locating the line to be graded, it was found necessary to run quite a different one from the preliminary survey, when Mr. Cook again confronted them, perched on the fence with a shotgun and revolvers. Engineer Redman came to this city and telegraped Col. Scott, at Louisville, the state of affairs.—*Cincinnati Enquirer.*

INDIANA ENTERPRISES.—VINCENNES, Ind., Oct. 21, 1883.—A narrow-guage road is projected from New Albany to Cannelton. Surveys have been made and a most vigorous effort is being put forth to insure the construction of this road. This road is intended to tap the coal mines of Perry county.

NEW ROAD.—The people of Goliad, Tex., are trying to get a tap road to connect at Cuero. Huntington has agreed to construct the road for a bonus of $2,000 per mile. Nearly all of the required amount has already been pledged, and work will doubtless commence in a short time.

ARTESIAN WELLS IN UTAH.—Salt Lake, Oct. 21.—The possibility of artesian wells in this valley has caused the liveliest stir within a few days consequent upon one no table success on Henry Dinwoody's farm, half a mile southwest of the Denver and Rio Grande depot in this city. The place had been a dry alfalfa pasture, when John A. Groesbeck put down near the farm house a flowing well. It is 115 feet deep, has a six-inch pipe and discharges 130 gallons per minute and cost $427. It flows water enough to irrigate a farm of 160 acres. The same vein was struck last spring by Mr. Groesbeck at his brick-yard on the west bank of the Jordan, but owing to improper treatment in sinking the pipe it did not flow freely. Simply boring a hole to the gravel stratum in which the water is found is not enough. When the water is struck is has to be handled carefully and pipe closed to make it rise. The water is supposed to be carried in a gravel stratum in connection with the water of Utah lake, thirty miles south, and about 250 feet higher than the site of this well, and it is supposed that anywhere this stratum is tapped a plentiful water supply can be had. If this theory is true the water problem for this valley is solved, but it remains to be fully proved.

WATER is sold in Vicksburg at 40 cents per barrel.

THE improvement at the river near the Union depot, Montgomery (Ala.), in filling the ravine and constructed the big sewer, is going on rapidly. The cost of the work will be $10,000.

NEW SAFETY BRIDGE GATE.—A model of a new safety bridge-gate has been invented in Chicago which is pronounced to be the best that has yet been submitted. The gates can be opened one at a time by the action of a lever which is operated on the bridge, and the closing or opening of them is not contingent on the swinging of the bridge. It is so arranged that the gates may be swung singly so that the bridge may be cleared without admitting new passengers. When the bridge closes the gates open automatically.

THE MEXICAN CENTRAL, according to the *Mexican Financier*, some time ago abandoned the ordering of its bridges in England on account of the intolerable delay and also the superior quality of the American work, and now it seems, according to its correspondent in Chihuahua, that owing to the delay in getting English rails a large quantity of American rails is to be forwarded from the United States, that the work of track-laying may be pushed without delay on the northern end. This is the first instance, the journal in question believes, of the exportation of American steel rails. In these days, when time is money, promptness in filling orders often tells in favor of the business of a country where the articles may be higher in cost than in countries more distant from the market or where shippers take there own time in forwarding. The nearness of the United States to Mexico will give its merchants and manufacturers a great advantage as soon as daily communication by rail is opened, and the business alliance of the two

countries will become firmer with each year. It will only need a well-considered policy of reciprocity to make this fact of the greatest moment in promoting mutual prosperity.

THE *North American Review* for November, by the liveliness and the sterling worth of the articles it contains, satisfies the requirements of the most exacting reader. Senator H. B. Anthony writes of "Limited Suffrage in Rhode Island," giving incidentally a highly interesting sketch of the early constitutional history of that little commonwealth, and setting forth the consideration which influenced its people in restricting the exercise of the electoral prerogative. Dr. Norvin Green, President of the Western Union Company, in an article entitled "The Government and the Telegraph," cites the provisions of the Federal Constitution and the determinations of the Supreme Court which appear to debar the General Government from assuming the management of the telegraph lines; and presents statistics designed to prove that the service in this country is both cheaper and more efficient than in any of the countries of Europe where the Government own the lines. The Rev. David N. Utter brings out from oblivion the record of tain alleged atrocious crimes of "John Brown of Ossawatomie." There are two scientific articles, namely, "Solar Physics," by Professor Balfour Stewart, and "Modern Explosives," by Gen. John Newton. W. H. Mallock contributes "Conversations with a Solitary," an imaginary passage-at-arms between a Radical and a Conservative, in which the two opposing theories of government and society are advocated with rare spirit and ingenuity of argument. In "Suggestions in regard to the Public Service" Green B. Raum offers certain facts going to prove that the clerks and other employés of the Government departments at Washington, even before the passage of the Civil Service act, were in the main both faithful and efficient. Finally, "Dr. Hammond's Estimate of Woman" is reviewed by Mrs. Lillie Devereux Blake, Miss Nina Morais, Mrs. Sara A. Underwood and Dr. Clemence S. Lozier. Fifty cents a copy; $5 a year. Published at 30 Lafayette Place, and sold by newsdealers generally.

A NEW HOTEL FOR SAVANNAH.—Mr. Henry Clair, proprietor of the Grand Union Hotel at Saratoga and the Metropolitan and Park Avenue hotels in New York, has offered to lease a hotel to be built in Savannah, Ga., at a cost of $350,000, for a term of ten years, pay 6 per cent. annually on the cost and all taxes and insurance. A meeting of the citizens of Savannah was held Saturday evening to consider the offer, at which an excellent spirit was manifested.

THE WARREN FOUNDRY, at Phillipsburg, having a capacity of 110 tons of cast-iron pipe per day, is running full-handed, with a good lot of immediate orders on hand. They have all they can do just now, and hope for a good future. Tippett & Wood, manufacturers of railroad turn-tables, standpipes and boilers, who give employment to an average of seventy-five men, have sufficient orders on hand for the present, but report the number of inquiries for work decreasing in the last two months. They say the outlook is not favorable. They are running full time. The American Sheet Iron Company, manufacturers of sheet and galvanized iron, employ 150 men and are running full time. Business is dull, however, and the demand for the future limited.—*Philadelphia Press.*

THE MICHIGAN BOULEVARD, Chicago, is now nearly finished. It is almost three miles long, fifty feet wide as a minimum, and north of 32nd street it is 100 feet. The road is composed, first, of a layer of crushed limestone, then a layer of gravel, then a one-inch layer of coarse crushed granite, and then a thinner layer of fine crushed granite. Each layer is well rolled, and the whole roadway required ten times as much rolling as a gravel roadway does. The crushed granite was furnished by a firm in Waterloo, Wis. The granite surface is more grateful to horses' feet than any roadway except a dirt road, and it makes no mud as gravel does. A hard rain runs off it at once. The total cost has been $700,000.

THE MISSISSIPPI JETTIES.—The establishment of deep water through the jetties at the mouth of the Mississippi River is now bearing fruit in the character of the shipping which now comes into the port of New Orleans. Before the completion of the imporvements for opening the mouth of the river, that city could be reached from the sea by vessels drawing only 18 or 19 feet at the utmost. For several years the class of vessels coming there has steadily increased in size and capacity, until now the largest ships that ply the ocean come. On the 14th the largest ship that ever visited the port passed through the jetties and anchored in front of the city. She is the British steamship Silvertown, built and used by the Silvertown India Rubber Telegraph Company for laying ocean cables. She is an iron steamer of 4,935 tons gross register, 388 ft. long, 55 ft. beam, and 34 ft. 6 in. deep. She has a cargo capacity for 15,000 bales of cotton, and has already a cargo engaged by her agents. No such marine monster has ever before been in the Mississippi River. About the same time the British steamship Egyptian Monarch, of the Monarch Line, of London, arrived. She is also a very large ship, of 3,916 tons gross register, with a cargo of steel rails. These great carriers can be operated more economically than small ships, which are being steadily driven into the trade with shallow-water ports.

VICKSBURG HARBOR.—The latest proposition for the improvement of the harbor of Vicksburg is to bring the mouth of the Yazoo River to the front of the city. The project is said to be practicable.

HOW THEY BROUGHT JAY GOULD TO THE WITNESS STAND.—The story of the disastrous experience of the subpœna server who tried to reach Russell Sage recalls the much more successful effort of the clerk of the Senate Committee on Education and Labor to capture the Senators' biggest witness, Mr. Jay Gould.

When the clerk went down to 71 Broadway with the Senatorial summons, duly signed and sealed, hid away in his coat pocket, and inquired for Mr. Gould, the guards at the door tried to bluff him off, just as Mr. Sage's henchman did with Clerk Ball. But the committee clerk was equal to the occasion. He refused to be bluffed, and marched right into the sanctum of the millionaire. "Mr. Gould," said he, smilingly, "I have a——" "Hold on, young man," responded the railroad and telegraph magnate, severely. "How do you know my name is Gould?"

"Know? How do I know? Why shouldn't I know what even the bootblack here knows? There's no mistaking Mr. Jay Gould when you see him. So you will permit me to hand you this summons. Senator Blair would like your testimony on the labor question."

"But I don't know anything about it," retorted Mr. Gould. "I don't want to be a witness. I won't go."

"But you must come. There's no getting out of it."

"Oh, you don't say so?"

"Yes, I do. It will cost you just $250, and imprisonment if the fine isn't paid, to stay away."

The millionaire paused. He studied the exterior of the clerk and the varied chirography of the summons in silence for a time, and then exclaimed:

"Well. Humph! I'll think about it. You may tell Senator Blair that I'll try to be there."

Jay Gould was there, as all newspaper readers know. As he was leaving the committee room to catch the elevator, to re-establish personal connections with the "street," the same clerk stopped him and said:

"Hold on a moment please, Mr. Gould. "You'll excuse me, but you've earned something by your testimony." Mr. Gould looked up in astonishment, and the clerk went on: "Yes, all witnesses are entitled to $3 each as a fee for their testimony. There is $3 due you, sir."

"But I don't want the $3."

"Give it to the poor then." With this philosophic and philanthropic suggestion the clerk held a pen and a blank receipt to secure the millionaire's signature. But the latter got frightened, and exclaimed:

"No, I can't sign that. It might look as if I took the money if I did." Then he adjusted his diamond studded cuffs, put on his hat, and bolted from the room. The $3 which would have gone to the poor is still in the Senate Committee's treasury.

THE Northern Pacific Bridge will cost $275,000. The people of Duluth can have a wagon road by subscribing liberally.

NEW BRIDGE.—It has been decided to build a new bridge over Cascade Creek, Rochester, Minn.

ALABAMA WATER FAMINE.—The water famine all through the "Black Belt," or prairie section of Alabama, is terrible. Wagons are busy daily hauling water from the lime creeks for miles, and men and beasts feel the fiery tread of the terrible scourge. Men watch the springs, and at early dawn rush to catch the flow of the night. Fortunate is he who is the first to reach the spring. Cattle are driven often several miles to water, and many are actually famishing. This scarcity extends over a great extent of the finest lands in Alabama.

THE Washington Monument has reached a height of 386 feet.

OHIO RIVER BRIDGE.—A board of engineer officers, composed of Lieut.-Cols. Cyrus B. Comstock, Godfred Weitzel and Wm. E. Merrill, has been appointed, to meet in New York, to consider and report upon a plan and location of a bridge across the Ohio River at Wheeling, W. Va., to be constructed by the Wheeling & Harrisburg Railway Company.

WHAT RAILWAYS CAN DO.—The lively city of Decatur, Ill., is an example of what railroads will do for a town. Ten years ago Decatur was a mud hole in the middle of the Illinois prairies. Now it is a city of 15,000 inhabitants.

IRON, METAL AND COAL MARKET.

PHILADELPHIA, OCT. 26.

Within 48 hours several large transactions in forge iron have been closed at $17@$17.50 at furnace, and a number of moderate transactions in foundry at $19 and $20.50 respectively. Considering the qualities of iron sold these are the lowest prices known this season, and the effect has been to check what was thought last week to be an improving tendency. Several buyers are in the market to-day ready to take advantage of the anxiety of sellers to realize. Some few furnaces have 5,000 to 15,000 tons stock on hand and are preparing to realize on the best possible terms. A few companies still adhere to old rates and consequently are not selling much. Upwards of 1,000 tons muck bars sold this week at $33.50 @$34. Sales of charcoal and anthracite blooms foot up 500 tons. Inquiries for carload lots nails have been made and sales in carload lots at $2.90@$3 have been made, with $2.85 as the inside limit. A number of inquiries were made for 50 to 100 ton lots of Merchant Bar within a few days, but very little business has come of it as yet. Card rate, 2.20c.; actual selling prices, 2@ 2.10c.; common, 1.80@1c. Orders for car purposes are coming to hand. The car works are generally busy. More orders for locomotives have been given. Mogul engines are being frequently ordered, the tendency being to use a larger type of engine. Large quantities of iron for engineering purposes are under inquiry, and leading manufacturers have inquiries covering 2,000 tons. Plate and structural iron unchanged. The expected business in steel rails has not been done. Makers refuse to drop below $37. There are rumors of business at less, but they cannot be authenticated. One or two lots of bridge rails have sold at $34.50. Negotiations are pending for cargo scrap, December delivery, at $22.50.

PITTSBURGH.

The iron trade in western Pennsylvania is still dragging along, buyers declining to purchase beyond current requirements for the same reasons which have held them back for several weeks. A few large transactions have taken place in forge iron, at $17@$17.50, and there are a number of offers from outside furnaces at this price; $17 is taken for native ore. Foundry ranges as usual, from $19@$21. Muck bars sold at $33; Merchant Bars, $1.80@$1.90; Nails in fair demand at $2.70@$2.80, and steel Rails are quoted firmly at $37.50@$38.50, while old material is not selling. The tone of the iron market is not strong, and some mills are restricting their output, on account of the falling off of inquiry. A portion of the force at the Edgar Thomson steel works is discharged. The Homestead Steel Rail Works will discontinue steel rail making. The glass strike continues, and manufacturers are importing glass to supply customers. The coal trade is active, but there are two or three strikes on hand, among the railroad pits, and one in the third and fourth pools, which promises to be a long one.

CINCINNATI.

The output of iron is on the decrease. Prices are weaker. Hanging Rock Charcoal, $22.25@$24.25; Neutral Coke, $18@$20.50; American Scotch, $18.50@$19@ $19.50; C. B. Car Wheel, $28; Southern Car Wheel, $27. Buyers look for a further decline, and therefore decline to buy in large lots. Several furnace companies contemplate blowing out as soon as present contracts are filled.

LOUISVILLE.

The demand for Southern iron continues active, and some brokers predict an upward tendency in prices, because of the fact that coke furnaces are well sold up. Prices are $22 for Southern, No. 1; $19 for American Scotch; $17 for Silver Gray, and $20@$15 for mill iron from No. 1 Charcoal, to white and mottled cold short.

COAL.

The rumors of a restriction in the output of anthracite coal have not been heard for a few days. The threat brought out the withheld demand in the East, and is leading to a larger distribution. The Western demand continues heavy, and the shading of prices which was begun last week, has been discontinued for the present. Production for week, 733,753, and for year, 24,172,836 tons. An increase of 2,142,834 tons over last year. The Reading is sold six weeks ahead; stocks at Port Richmond, 60,000 tons. The coal trade expects to be able to sell its full output at present rates, up to the inauguration of the usual three-quarter time for winter. Careful inquiry as to the probable requirements East and West has led the anthracite managers to the determination of holding firmly to circular rates. The local manufacturing demand is not improving, and the larger sizes are still broken up for domestic use. New York interests are the first to ask for suspension, as that market is always the first to be over-stocked. The Reading, the Lehigh, and some others are well sold up in Western markets. The Reading company alone has increased its shipments 100 per cent. in 4 weeks. The bituminous shipments East foot up for year 3,871,214 tons. Cumberland shipments, 1,972,593 tons; average shipments of soft coal to eastern tidewater markets, 160,000 tons per week. Average daily anthracite production 120,000 tons.